# SELECTED

# **SWATER**RESOURCES ABSTRACTS



VOLUME 17, NUMBER 9 SEPTEMBER 1984

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# SELECTED WATER RESOURCES ABSTRACTS

A monthly publication of the Geological Survey U.S. Department of the Interior

VOLUME 17, NUMBER 9 SEPTEMBER 1984

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The Secretary of the interior has determined that the publication of the periodical is necessary in the transaction of the public business required by law of this Department. Use of funds for printing this periodical has been approved by the Office of Management and Budget through September 30, 1985.

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#### **PREFACE**

elected Water Resources Abstracts, a monthly S elected Water resources Auditory, journal, includes abstracts of current and earlier reports, and pertinent monographs, journal articles, reports, and other publication formats. These documents cover water resources as treated in the life, physical, and social sciences and the related engineering and legal aspects of the characteristics, supply condition, conservation, control, use, or management of water resources. Each abstract includes a full bibliographic citation and a set of descriptors which are listed in the Water Resources Thesaurus. The abstract entries are classified into 10 fields and 60 groups similar to the water resources research categories established by the Committee on Water Resources Research of the then Federal Council for Science and Technology.

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Comments and suggestions concerning the contents and arrangement of this bulletin are welcome.

Water Resources Scientific Information Center U.S. Geological Survey, MS 421 Reston, VA 22092

#### SUBJECT FIELDS AND GROUPS

Please use the edge index on the back cover to locate Subject Fields and Indexes.

#### 01 NATURE OF WATER

Includes the following Groups: Properties; Aqueous Solutions and Suspensions.

#### 02 WATER CYCLE

Includes the following Groups: General; Precipitation; Snow, Ice, and Frost; Evaporation and Transpiration; Streamflow and Runoff; Groundwater; Water in Soils; Lakes; Water in Plants; Erosion and Sedimentation; Chemical Processes; Estuaries.

#### 03 WATER SUPPLY AUGMENTATION AND CONSERVATION

Includes the following Groups: Saline Water Conversion; Water Yield Improvement; Use of Water of Impaired Quality; Conservation in Domestic and Municipal Use; Conservation in Industry; Conservation in Agriculture.

#### 04 WATER QUANTITY MANAGEMENT AND CONTROL

Includes the following Groups: Control of Water on the Surface; Groundwater Management; Effects on Water of Man's Nonwater Activities; Watershed Protection.

#### 05 WATER QUALITY MANAGEMENT AND PROTECTION

Includes the following Groups: Identification of Pollutants; Sources of Pollution; Effects of Pollution; Waste Treatment Processes; Ultimate Disposal of Wastes; Water Treatment and Quality Alteration; Water Quality Control.

#### 06 WATER RESOURCES PLANNING

Includes the following Groups: Techniques of Planning; Evaluation Process; Cost Allocation, Cost Sharing, Pricing/Repayment; Water Demand; Water Law and Institutions; Nonstructural Alternatives; Ecologic Impact of Water Development.

#### 07 RESOURCES DATA

Includes the following Groups: Network Design; Data Acquisition; Evaluation, Processing and Publication.

#### 08 ENGINEERING WORKS

Includes the following Groups: Structures; Hydraulics; Hydraulic Machinery; Soil Mechanics; Rock Mechanics and Geology; Concrete; Materials; Rapid Excavation; Fisheries Engineering.

#### 09 MANPOWER, GRANTS, AND FACILITIES

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#### 10 SCIENTIFIC AND TECHNICAL INFORMATION

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#### SELECTED WATER RESOURCES ABSTRACTS

#### 1. NATURE OF WATER

#### 1A. Properties

QUALITATIVE PROPERTIES OF INTERNAL MOTIONS OF LAKE GENEVA (QUALITATIVE EIGENSCHAFTEN INTERNER BEWEGUNGEN DES GENFERSEES),

Ecole Polytechnique Federale de Lausanne (Swit-

zeriano).

V. M. Bohle, and C. Perrinjaquet.

Schweizerische Zeitschrift für Hydrologie, Vol.

45, No. 1, p 196-218, October, 1983. 9 Fig, 3 Tab,

Descriptors: \*Water quality data, \*Hydrologic properties, \*Lake Geneva, Water currents, Hydrodynamics, Mathematical models, Model studies, Wind-driven currents, Wind waves, Waves, Inter-

The internal motions of the Lake Geneva are classified by means of the quotient 'Q' of the kinetic energies in alongshore and on-/offshore directions. Theoretical values for the frequency depending quotient are estimated for three simple model-geometries. A method of fourier spectral analysis was used which regards the limitations of the data set for the 1977/1978 measurement campaign. The internal motions of the Lake Geneva, as a response to external forcing, are relations of the frequency to the quotient of kinetic energies, which are, depending on the season, the slope and the width of the basin. (Murphy-IVI)

#### 2. WATER CYCLE

#### 2A. General

A MODEL FOR ESTIMATING ONE-MINUTE

A MODEL FUR ESTIMATION OF RAINFALL RATES, Air Force Geophysics Lab., Hanscom AFB, MA. P. Tattleman, and K. G. Scharr. Journal of Climatology and Applied Meteorology, Vol. 22, No. 9, p 1575-1580, September, 1983. 7

Descriptors: \*Rainfall, \*Model studies, Estimating, Multiple regression analysis, Mathematical models, Temperature effects.

A model for estimating one-minute rainfall rates uses stepwise multiple regression analysis. The model has six regression equations to estimate rates that equal or exceed 0.01, 0.05, 0.10, 0.50, 1.0 and 2.0 percent of the time during a month at a given location. Information required to make the estimates consists of monthly mean temperature, monthly mean precipitation, number of days in the month with precipitation (based on any of three month with precipitation (based on any of three month with precipitation (based on any of three threshold values that define a rainy day), and latitude. The model is not valid when the mean monthly temperature is less than freezing, when there is less than one rainy day in the month, or when a precipitation index is less than 2 mm/day. When there are between one and three rainy days during the month, the model may estimate rates for each of the exceedance levels, which when integrated, indicate a total rainfall two or more times greater than the monthly mean precipitation Under these circumstances heavy, but infrequent convective precipitation accounts for just about all of the precipitation in the month. Therefore, the most accurate estimates are for the two or three lowest exceedance levels, and significant rainfall may not occur more often than 0.5% of the month. These possibilities should be considered before accepting rate estimates in arid locations. (Murphy-IV1) W84-03045

RESEARCH ON WATERSHED HYDROLOGY AT THE UNIVERSITY OF ILLINOIS, Illinois Univ. at Urbana-Champaign. B. C. Yen.

Journal of Hydrology, Vol. 68, p 3-17, 1984. 2 Fig,

Descriptors: \*Research, \*Watersheds, \*Hydrology, Reviews, Mathematical models, Rainfall-runoff relationships, Statistical analysis.

Research on watershed hydrology at the University of Illinois started in the 1880's with the developty of Illinois started in the 1880's with the development of the Talbot waterway formula. In the following 60 years, studies on watershed hydrology were continued at Illinois on a relatively limited local scope. Activities on the subject were considerably expanded after Dr. Ven Te Chow joined the University in 1948. Activities in the lumped system approach, experimental investigation of runoff from rainfall, hydraulic based approach and analyses of spatial and temporal distributions of rainfall for watershed runoff are summarized. (Murnby-IVI) (Murphy-IVI) W84-03333

MODELLING OF HYDROLOGIC PROCESSES IN A SMALL URBANIZED HILLSLOPE BASIN WITH COMMENTS ON THE EFFECTS OF URBANIZATION, Tokyo Univ. (Japan). Dept. of Civil Engineering. Y. Ando, K. Musiake, and Y. Takahasi. Journal of Hydrology, Vol. 68, p 61-63, 1984. 16 Fig. 6 Tab. 3 Ref.

Fig, 6 Tab, 3 Ref.

Descriptors: \*Hydrologic models, \*Urban runoff, \*Urbanization, \*Urban hydrology, Urban drainage, Urban watersheds, Rainfall, Evaporation, Groundwater movement, Groundwater recharge, Impervious area, Tokyo, Japan.

A clarification of the hydrologic processes was developed, based on a study of a small urbanized experimental basin in the Tama hills in the western suburbs of Tokyo, Japan. Impervious areas such as roofs and roads contribute to direct runoff. Infiltration areas do not contribute to direct runoff. ndwater flow derives from the unconfined aquifer, and is in proportion to the second power of groundwater storage. Groundwater recharge is in proportion to soil-moisture excess. Evapotranspiration in the infiltration area of the urban basin is the same as that in the infiltration area of the is the same as that in the inhitration area of the natural basin, but the evaporation in the impervious area of the urban basin occurs to the extent of 2mm accompanied by rainfall. There were also urbanization effects on hydrologic processes. The contributing area to direct runoff is the saturated area for the natural basin, as against the impervious area for the urbanized basin. Urbanization effects on groundwater runoff are relatively small. Decrease in the ratio of the infiltration area to the catchment area, due to urbanization, has a large effect on the groundwater recharge process. Urbanization decreases evapotranspiration. (Murphy-

RAINFALL-RUNOFF RELATIONSHIPS OF SOME CATCHMENTS WITH KARSTIC GEO-MORPHOLOGY UNDER ARID TO SEMI-ARID CONDITIONS,

Ministry of Agriculture, Reclamation and Land Development, Benghazi (Libya). Dept. of Water and Soil.

M. R. de Vera

Journal of Hydrology, Vol. 68, p 85-93, 1984. 3 Fig. 2 Tab, 10 Ref.

Descriptors: \*Rainfall-runoff relationships, \*Karst hydrology, Semiarid climates, Catchments, Arid climates, Mathematical equations, Rainfall intensity, Soil water.

Review of available consultant reports on water resources studies in the northeastern zone of Libya shows that fourteen catchments have good data on rainfall and runoff for analysis, but only eight wadis have sufficient flood data of at least eleven wadis have sufficient flood data of at least eleven events for linear regression analysis. The prevailing surface geology of practically all the catchments is marly limestone, which is conducive to karstification processes. Since wadi flow is a direct response to rainfall, proper consideration of the other factors that affect runoff would result in a better functional relationship for runoff estimation. Results of regression analysis of rainfall and runoff show that the correlation coefficient ranges from

0.219 to 0.89. This means that 4.8 to 80.3% of the 0.219 to 0.39. This means that 4.8 to 80.3% of the variation in runoff can be accounted for by the regression equation. The qualitative effect of karstification is reflected in the highly variable ratio between rainfall and runoff. The runoff coefficient, which is generally taken as the ratio of runoff to rainfall, should be used with caution for estimating historical or future runoff from catchments with the prestrict of the company of the control of nstorical or tuture runoff from catchments with karstic geomorphology, especially under arid to semi-arid conditions. A relationship expressing runoff as a function of rainfall intensity, rainfall duration, antecedent soil moisture, depth of unsastu-rated zone and degree of karstification should be investigated. (Baker-IVI) W84-03338

APPLICATION OF ENVIRONMENTAL ISO-TOPE TRACERS TO MODELING IN HY-DROLOGY,

International Atomic Energy Agency, Vienna (Austria).

T. Dincer, and G. H. Davis. Journal of Hydrology, Vol. 68, p 95-113, 1984. 11 Fig. 31 Ref.

Descriptors: \*Hydrologic models, \*Isotopic tracers, Hydrology, Groundwater recharge, Soil water, Evaporation, Climates, Precipitation, Tritium, Deuterium, Oxygen, Lakes, Swamps, Groundwater movement.

Chemical transport models employing the environ-mental isotopes found in natural waters are now practical due to advancements made in nuclear science and computer development. The most con-servative tracers of water known are the heavy servative tracers of water known are the heavy isotopes of hydrogen, deuterium and tritium. The heavy stable oxygen isotope, O-18, circulates in tandem with deuterium in the hydrologic cycle. Tritium fallout varies seasonally and annually in a systematic fashion and, due to its property of radioactive decay, is highly useful for dating time of recharge of soil moisture and groundwater. C-14 is valuable for tracing old groundwater due to its relatively long half-life of 5568 yr. However, detailed knowledge of the hydrochemistry of the system is needed for successful modeling. Deuterium and O-18 reflect the temperature at which um and O-18 reflect the temperature at which precipitation condensed. They show pronounced seasonal variability and also the effects of altitude, seasonal Variabulty and also the effects of attitude, latitude, distance from the sea, amount of precipitation, history of evaporation, and long-period climatic cycles. Principal areas of application of environmental isotopes to hydrologic modeling have been in soil moisture transport, modeling of mixing and evapotranspiration in large lakes and swamps, and the collection of the property of the glacial-ice movement, groundwater flow, and transport of contaminants in groundwater. (Baker W84-03339

LONG-TERM HYDROLOGIC EVENTS FROM SHORT-TERM RECORDS,

N. Bethlahmy. Journal of Hydrology, Vol. 68, p 141-148, 1984. 2 Fig, 1 Tab, 9 Ref.

Descriptors: \*Hydrologic models, \*Hydrologic data, \*Flood forecasting, Mathematical models, Mathematical analysis, River forecasting, River flow, Flood flow, Low flow

A new method based on ranks calculates the magnitude of hydrologic events associated with any desired probability. The system utilizes a transformation based on the median that yields positive values less than one. The method is substantiated through internal evidence. This method differs in a unique way from methods that define a distribution and then relate the probability of a variable to its deviation from the mean. Both the variable and its deviation from the mean. Both the variable and its rank (its position in an ordered array) are transformed in an identical fashion. Because the time span N is brief, the hydrologist will normally be concerned with the magnitude of a variable at an extrapolated time T that is greater than sampling time N. As a result, n sub T for floods is always smaller than n sub N, and consequently q sub T will always exceed q sub N. If an extraordinarily large flood occurs during the base period N, then

#### Group 2A-General

extrapolated flood will be even larger. The reverse would occur for low flows. (Muphy-IVI) W84-03340

STOCHASTIC NATURE OF OUTPUTS FROM CONCEPTUAL RESERVOIR MODEL CAS-CADES

Waterloo Univ. (Ontario). Dept. of Civil Engineer

ing. T. E. Unny, and Karmeshu.

Journal of Hydrology, Vol. 68, p 161-180, 1984. 2 Tab, 14 Ref.

Descriptors: \*Stochastic process, \*Reservoirs, \*Cascades, Model studies, Rainfall, Controlled storage, Stochastic hydrology, Evaporation, Catchment areas, Overflow.

Through consideration of one or more conceptual reservoirs to model the time distribution of out-flows from catchments fed by rainfall, the characteristics of random rainfall inputs (including evapo-ration and catchment abstractions) are modified and catchment outflows are obtained with moment and calcimient outlinows are contained with indiner characteristics that are functions of the parameters describing the nature of the conceptual reservoirs. The stochastic differential equation describes the storage balance in the conceptual reservoir. The Nash cascade is expanded into a stochastic reservoir cascade. The variations in no more than two parameters representing the nature of the concep-tual reservoir are sufficient to describe catchment outflows with widely varying moment properties and correlation characteristics. (Murphy-IVI) W84-03342

IDENTIFICATION AND PREDICTION OF NONLINEAR HYDROLOGIC SYSTEMS BY THE FILTER-SEPARATION AUTOREGRESSIVE (AR) METHOD: EXTENSION TO HOURLY HYDROLOGIC DATA, Tokyo Inst. of Tech. (Japan). Dept. of Civil Engi-

M. Hino, and M. Hasebe. Journal of Hydrology, Vol. 68, p 181-210, 1984. 16 Fig, 5 Tab, 9 Ref.

Descriptors: \*Hydrologic models, \*Rainfall-runoff relationships, Groundwater runoff, Surface runoff, Groundwater flow, Estimating, Predicting, Rain-

A direct extension of an earlier proposed method for the daily runoff data analysis may not be appli-cable to the analysis of hourly hydrologic data. A few modifications are suggested. The cut-off fre-quency to separate the total runoff time series into component runoffs was determined by the slope of the semi-logarithmic plot of the recession curve. Coefficients of the autoregressive moving average model applied to each of the subsystems were determined by the least-squares criterion from the recession period data when rainfall stopped. Nonrecession period data when ramani stopped. Non-linear hourly hydrologic systems appeared easily and precisely identified by this method. Each sub-system of the surface runoff, interflow and ground-water runoff is linear. The nonlinearity of the rainfall-runoff system is caused mainly by the non-linearity of the separation of rainfall into compo-nent rainfalls. The nonlinear separation rule of rainfall into rainfall components is derived from inversely estimated rainfalls. Time series of hourly inversely estimated rainfalls. Time series of hourly rainfalls can be inversely estimated from hourly runoff by this method and it compares well with the observed effective precipitation time series re-gardless of the size of watershed. (Baker-IVI) W84-03342

IDENTIFICATION OF A VOLTERRA SERIES CONCEPTUAL MODEL BASED ON A CASCADE OF NONLINEAR RESERVOIRS, Technion - Israel Inst. of Tech, Haifa. M. H. Diskin, A. Boneh, and A. Golan. Journal of Hydrology, Vol. 68, p 231-245, 1984. 5 Fig. 3 Tab, 14 Ref.

Descriptors: \*Rainfall-runoff relationships, \*Reservoirs, \*Model studies, Volterra series model, Rainfall, Runoff, Surface runoff, Cache River.

The Volterra series model based on a cascade of nonlinear reservoirs was originally proposed for the description of flood routing in open channels. Its possible application for modeling the surface runoff system was examined. The model fulfills all the conditions specified for kernel functions of conservative systems, as well as additional conditions derived from observations of the nonlinearity observed in surface runoff systems. Other features include the compactness of the model, the linkage between the two kernel functions that form the model, and the physical basis of the equations that model, and the physical basis of the equations that describe the kernel functions. For the Cache River data used, the optimal values of the parameters of a data used, the optimal values of the parameters of a model based on a cascade of linear reservoirs can serve as a good starting point for the search for optimal parameters for the model based on a cascade of nonlinear reservoirs. The number of reservoirs in the cascade is restricted to be an integer, and the number is relatively small. The number is the same for both the linear and the nonlinear models. (Baker-IVI)
W84-03345

HOW TO USE A SINGLE-PARAMETER CON-CEPTUAL MODEL IN HYDROLOGY (QUE PEUT-ON FAIRE EN HYDROLOGIE AVEC UN MODELE CONCEPTUEL A UN SEUL PARA-METRE

C. Michel. Houille Blanche, No. 1, p 39-44, 1983. 9 Fig, 7 Ref.

Descriptors: \*Hydrologic models, \*Mathematical models, Rural areas, Drainage basins, Rainfall, Evaporation, Model studies, France.

A single parameter conceptual model was developed for representing the daily flows of the typical Orgeval basin in an acceptable manner. The basin used in this study is a typical example of the small rural basins found in the north of France. In the model, there are two "reservoirs": the superficial reservoir (S) receives a fraction of the rainfall and is subject to evaporation; the routage reservoir (R) receives the other fraction of the rainfall and it is receives the other fraction of the rainfall and it is from here that water drains. The model was first tested using a single parameter. When a second parameter was introduced, the results were found to be better during a period of filling, but not as good during a period of control. Better results were obtained when the model was modified so that there are five modules functioning in parallel, each representing 1/5 of the sloping basin. (Moore-IVI) IVI) W84-03357

SEASONAL FLUCTUATIONS IN THE CARBON DIOXIDE PARTIAL PRESSURE IN A CAVE ATMOSPHERE.

Pennsylvania State Univ., University Park. Dept. of Geosciences

J. W. Troester, and W. B. White. Water Resources Research, Vol. 20, No. 1, p 153-156, January 1984. 3 Fig, 21 Ref.

Descriptors: \*Carbon dioxide, \*Caves, \*Seasonal variation, Tytoona Cave, Sinking Valley, Pennsylvania, Water flow, Partial pressures.

Many studies of the geochemistry of groundwater in carbonate terrains over the past decade have found it convenient and useful to characterize the found it convenient and useful to characterize the water chemistry by a theoretical carbon-dioxide partial pressure. Carbon dioxide partial pressures were measured at 2 week intervals in a segment of a cave passage isolated by a water trap from mixing with outside air. The levels of CO2 fluctuated from 0.03 to 0.4 vol % being lowest in the winter and highest in the summer. The CO2 measured directly in the atmosphere and the CO2 partial pressure calculated from the pH and alkalinity of the underground stream have similar seasonal profiles. Evidence is strong that the CO2 concentration in both the conduit water and in the cave atmosphere is related to the growing season and to the type of soil and plant cover on the land surfce of the drainage basin nearby. (Baker-IVI) W84-03422

MEIXNER FUNCTIONS FOR DERIVATION OF THE UNIT HYDROGRAPH.

Louisiana State Univ., Baton Rouge. Dept. of Civil Engineering. V. P. Singh, and R. C. McCann. Advances in Water Resources, Vol. 6, No. 3, p 157-164, September, 1983. 14 Fig, 17 Ref.

Descriptors: \*Rainfall-runoff relationships, \*Unit hydrographs, Meixner functions, Watersheds, Rainfall, Runoff, Convolutions, Mathematical equations, Hydrographs, Linear programs

The Meixner functions were used to relate the effective rainfall, the direct runoff and the unit effective rainfall, the direct runoff and the unit hydrograph (UH) through linkage equations. The linkage equations were then used to derive the UH for given rainfall-runoff data on a small agricultural watershed. The Z-transform was effectively employed to establish linkage equations relating Meixner coefficients of the UH to those of the effective rainfall and the direct runoff. Meixner functions effectively derived the UH for the given watershed and synthesized the direct runoff hydrograph satisfactorily. Meixner functions produced a UH which was not unduly sensitive to data errors. These functions compare favorably with the least These functions compare favorably with the least squares and linear programming methods. (Baker-W84-03466

#### 2B. Precipitation

SOME SPATIAL CHARACTERISTICS OF DROUGHT DURATION IN THE UNITED

National Climatic Data Center, Asheville, NC.

Journal of Climate and Applied Meteorology, Vol 22, No. 8, p 1356-1366, August, 1983. 9 Fig, 1 Tab,

Descriptors: \*Drought, \*Mathematical studies, Statistical analysis, Correlation analysis, Palmer Drought Severity Index, Precipitation.

er Drought Severity Index (PDSI), as calculated from state averages of temperature and precipitation and from numerous single station nalyses, demonstrates that droughts (as defined by ne PDSI) persist longer in the interior of the the PDSI) persist longer in the interior of the United States than in areas farther east or west. Contingency tables which use the PDSI as the predictor for the following one-month, six-month and twelve-month precipitation anomalies (and also anomalies of precipitation minus potential evapotranspiration), are generally characterized by significantly greater skill in the interior portions of the United States, confirming the notion that spells of abnormally dry or wet weather do have more persistence in the Rocky Mountain and High Plains states than farther east or west. The forecasts from the 'operational' PDSIs were not a significant improvement from the precipitation persistence forecasts. (Murphy-IVI) W84-03043

RAINFALL ANALYSIS BY POWER TRANSFORMATION,

Mosul Univ. (Iraq). Dept. of Irrigation and Drain-

H. Rasheed, A. S. Aldabagh, and M. V.

Ramamoorthy.

Journal of Climate and Applied Meteorology, Vol. 22, No. 8, p 1411-1415, August, 1983. 2 Fig, 5 Tab, 10 Ref.

Descriptors: \*Rainfall, \*Measuring instruments, Mathematical studies, Power transformation, Precipitation, Rain gages.

Power transformation normalized the peak daily and peak monthly rainfall at various raingage sta-tions in Iraq. There were excellent correlations tions in Iraq. There were excellent correlations between the coefficient of skewness (C sub s) and a parameter for power transformation, coefficient of kurtosis (C sub k) and the parameter for power transformation, and between C sub s and C sub k. The relationship between C sub s and the parameter for the coefficient of the coefficien the relationship between C sales and the parameter for power transformation will develop an estimation procedure for calculation of the transformation parameter. The method eliminates the use

#### Precipitation—Group 2B

of trial and error for estimating the parameter for power transformation. The annual series of month-jup peak rainfall data shows that the log-Pearson Type III distribution offers estimates of rainfall similar to those of a power transformation. However, for data of less than 30 years period, a SMEMAX transformation gives estimates similar to those of a power transformation. A Gumbel distribution gives higher estimates. For daily peak rainfall data, log-Pearson Type III and Gumbel distributions give estimates close to those obtained by power transformation. SMEMAX transformation offers consistent lower estimates. (Murphy-IVI) 35 W84-03044

POTOMAC RIVER STREAMFLOW SINCE 1730 AS RECONSTRUCTED BY TREE RINGS, Lamont-Doherty Geological Observatory, Pali-

sades, NY.
For primary bibliographic entry see Field 2E.
W84-03145

PRECIPITATION OVER NORTHERN ITALY: A DESCRIPTION BY MEANS OF PRINCIPAL COMPONENT ANALYSIS,

SERMA, Milan (Italy), F. Molteni, P. Bonelli, and P. Bacci. Journal of Climate and Applied Meteorology, Vol. 22, No. 10, p 1738-1752, October, 1983. 10 Fig, 3 Tab, 35 Ref.

Descriptors: \*Precipitation, \*Italy, \*Principal component analysis, Rainfall, Orographic precipitation.

The data sample used for the principal component analysis is formed by daily precipitation totals recorded at 35 rainfall stations during the periods October 1978-April 1979 and October 1979-April 1979 and October 1979-April 1980. A spatial analysis is applied to the square roots of daily data and of their 3- and 5-day means, working on cross-product matrices obtained from both standardized and nonstandardized values. Four principal components (PCs) can be selected: the first is an index of the mean rainfall; the second represents the longitudinal differences; the third and fourth are representative of orographic anomalies. For daily data, these 4 PCs account for more than 80% of the total variance (since cross-product matrices are used in the analysis, the term variance must be interpreted as mean square value); this percentage is slightly higher working on nonstand-ardized values, but with standardized values the explained variance is distributed more uniformly among the 35 rainfall stations. Passing to 3- and 5-day means, the cumulative variance of the first 4 PCs increases; in particular, there is an increase for the first 4 PCs and a decrease for the others. These variations are compared with stability indices computed from the daily values of the PCs. The properties of high rainfall cases are well described by the PCs of 3-day values, whereas 5-day values are excessively smoothed. An orthogonal rotation, for which the criterion is based on physical considerations, is then applied to the first 4 PCs of nonstandardized daily values, the rotated patterns show a clear physical significance and can be related to different types of circulations in the lower troposphere over Europe. (Murphy-IVI) W84-03146

THE UTILIZATION OF NIMBUS-7 SMMR MEASUREMENTS TO DELINEATE RAIN-FALLOVER LAND.

National Aeronautics and Space Administration, Greenbelt, MD. Goddard Space Flight Center. E. Rodgers, and H. Siddalingaiah. Journal of Climate and Applied Meteorology, Vol. 22, No. 10, p 1753-1763, October, 1983. 14 Fig, 10 Tab, 13 Ref.

Descriptors: \*Nimbus-7, \*Scanning multichannel microwave radiometer, \*Rainfall, \*Satellite technology, Remote sensing, Rainfall distribution, Rainfall intensity, Net rainfall, Meteorological data collection

An empirical-statistical analysis using data from the Nimbus-7 scanning multichannel microwave radiometer (SMMR) detects rainfall areas over

land. The addition of information from a lower frequency channel (18.0 or 10.7 GHz) improves the discrimination of rain from wet ground achieved by using a single frequency dual polarized (37 GHz) channel alone. Rain areas over land were determined from ground-based radar as were areas adjacent and upwind from rain areas. The probability for the mean vectors of any two populations being identical is less than 0.01 for classes sampled with surface thermodynamic temperatures > or = to 15 C, except for the rain over land and wet ground classes observed with the SMMR 37 GHz channel. None of the classes were signficiantly different for the classes with surface thermodynamic temperatures less than 15 C. For areas of large-scale heavy rainfall, a Fisher linear discriminant classifier determined the lower frequency SMMR channels were not better able to delineate rain from wet ground than the 37 GHz channel. In areas of light rain and/or where the rain area did not fill the lower frequency instantaneous field of view the lower channels were not able to differentiate rain from wet ground. (Murphy-IVI) W84-03147

SIMULATION OF A RAINFALL RECORD FOR THE SITE OF A NEW AGRICULTURAL DE-VELOPMENT: AN EXAMPLE FROM NORTH-ERN SYRIA,

ERN SYRIA, Reading Univ. (England). Dept. of Agricultural Botany.

Botany. M. D. Dennett, J. A. Rodgers, and J. D. H. Keatinge.

Keatinge. Agricultural Meteorology, Vol. 29, No. 4, p 237-258, 1983. 8 Fig, 4 Tab, 10 Ref.

Descriptors: \*Rainfall, \*Estimating, Syria, Model studies, Tel Hadya, Rainfall distribution, Precipitation.

A major concern among International Centre for Agricultural Research in the Dry Areas (ICARDA) scientists is the impact of weather, particularly rainfall, on crop productivity and, therefore it is important to know whether the experimental years to date were relatively wet or dry and how they fit into the long term expectations. Daily rainfall records for two sites in Nothern Syria are compared by fitting probability and frequency models to the observations. A model is interpolated for an experimental site at Tel Hadya, a site which is intermediate between the weather stations and for which long term measurements are not available. In dry years, at least, there may be some persistence of dryness over several months. Such long term effects are not included in the model, and thus it slightly overestimates rainfall amounts over long periods in dry years. It is possible to examine the rainfall patterns in recent years and place them in a long term context. (Baker-IVI) W84-03211

SUPERCOOLED LIQUID WATER AND ICE CRYSTAL DISTRIBUTIONS WITHIN SIERRA NEVADA WINTER STORMS,

Bureau of Reclamation, Auburn, CA. Auburn-Folsom South Unit. M. F. Heggli, L. Vardiman, R. E. Stewart, and A.

Huggins. Journal of Climate and Applied Meteorology, Vol. 22, No. 11, p 1875-1886, November, 1983. 12 Fig, 2 Tab, 15 Ref.

Descriptors: \*Climates, \*Clouds, \*Precipitation, Snow, Sierra Nevada Mountains, Storms, Measuring instruments, Meteorological data collections, Physical properties.

Cloud physics data measured by aircraft during two successive winter field seasons (1978-79 and 1979-80) operating over the Sierra Nevada Range have been examined to determine the distributions of supercooled liquid water and ice crystals. The data has provided a close look at the supercooled liquid water content and ice crystal concentration in winter storms. The cellular echo type clouds clearly exhibit the most desirable characteristics of significant liquid water and relatively little ice. The area-wide and banded echo type clouds provide fewer instances of significant supercooled water and have an abundance of ice crystals. Liquid

water maxima were found near the freezing level irrespective of percipitation echo type. Convective clouds provided the greatest likelihood of significant supercooled water. The largest water contents were observed at the greatest temperatures, usually zero to minus five degrees C. Such climatological information suggests that a weather modification program should concentrate primarily on the convective clouds in order to enhance snowfall. (Baker-IVI)
W84-01303

DROUGHTS AND FAMINES IN INDIA - A HISTORICAL PERSPECTIVE,

Meteorological Office, New Delhi (India). P. K. Das.

Mausam, Vol. 34, No. 2, p 123-130, April, 1983. 3 Fig, 6 Tab, 13 Ref.

Descriptors: \*Drought, \*Water shortage, India, Drought index, Water supply, Stochastic hydrology, Model studies.

Droughts and famines are associated with periods of decline in food production. But, it is by no means clear that a drought was always a precursor of famine, because the latter, a situation of distress, might have been caused by lack of communications and other economic factors. Historical records suggest that there were 14 famines between the 11th and 17th centuries and another 12 famines in the 90 year period from 1869 to 1958. A sharp increase was noted in number between 1860 and 1908. Famines did not always coincide with years of drought. Many famines appear to have been caused by a lack of adequate communication. Drought indices have been developed in recent years which have noted droughts in 1951, 1965-66, 1972, and 1974. A stochastic prediction technique is based on autoregression for monsoon rainfall. This is a variation of ARIMA, which has been used in econometrics but has an interesting application in Meteorology. (Baker-IVI)

A THEORETICAL STUDY REGARDING HET-EROGENEITY OF RAINFALL OVER MADHYA MAHARASTRA,

Meteorological Office, Poona (India). A. K. Mukherjee, and K. C. S. Ray. Mausam, Vol. 34, No. 2, p 167-170, April, 1983. 4 Fig. 1 Tab. 6 Ref.

Descriptors: \*Rainfall, \*Seasonal variation, Madhya Maharashtra, Western Ghats, Rainfall distribution, Model studies, Orography, Geography, Forecasting, India.

A line of delineation running north-south across the districts of Madhya Maharashtra was suggested while studying the normal rainfall over these districts. This line roughly distinguishes the rainfall distribution in the talukas to the west and the talukas to the east during the months of July and August. This heterogeneity of rainfall on both sides of the line of delineation is explained. A two dimensional model for orographic rainfall was used. The line of delineation was shown to roughly coincide with the place where the rainfall due to orography becomes nearly zero in the east side of the Western Ghats. Forecasts for rainfall in these two sections during July and August should be made from different considerations. (Baker-IVI) W84-03305

THE SUB-DIVISIONAL RAINFALL DISTRIBUTION ACROSS THE WESTERN GHATS DURING THE SOUTHWEST MONSOON SEASON.

Meteorological Office, Poona (India). G. Ramachandran, and A. K. Banerjee. Mausam, Vol. 34, No. 2, p 179-184, April, 1983. 3 Fig. 3 Tab, 2 Ref.

Descriptors: \*Rainfall distribution, Western Ghats, Monsoons, Wind, Tamil Nadu, India, Karnataka, Madhya Maharashtra, Rainfall.

#### **Group 2B—Precipitation**

The behavior of rainfall across the entire length of the Western Ghats has been examined for the monsoon season from June to mid-September over a period of 7 years from 1970-1976. The weekly rainfall between a pair of sub-divisions across and adjoining the Western Ghats during the southwest monsoon season is not necessarily positively correlated along the entire length of the mountain barnated along the entire length of the mountain our-rier. The relationship varies from one region to another. In the nothern sector between the pair of sub-divisions Konkan and Madhya Maharashtra the correlation coefficient is +.67. Moving south-wards in the central sector the correlation coefficient between the pair of sub-divisions, coastal Karnataka and Interior Karnataka, remains positive but decreases to +0.30. But moving still southwards, into the southern sector, the relationsouthwards, into the southern sector, the relation-ship reverses and a negative correction of -25 is obtained betwen Kerala and Tamil Nadu. The correlation coefficients are all significant at the 1% level. The changes in the correlation coefficients may be due to the presence of a low-level trough may be due to the presence of a low-level trough in the westerlies across Tamil Nadu during weak monsoon epochs. The relationship in the weekly rainfall between the pairs of sub-divisions across the Western Ghats may serve as a useful tool to predict rainfall distribution across different regions of the Ghats both in weak and strong monsoon phases. (Baker-IVI) W84-03306

INTERPOLATION OF SHORT DURATION RAINFALL FROM 24-HOUR RAINFALL IN LOWER GODAVARI BASIN, Meteorological Office, New Delhi (India). D. V. L. N. Rao, S. C. Goyal, and S. N. Kathuria. Mausam, Vol. 34, No. 3, p 291-298, July, 1983. 1 Fig. 5 Tab, 4 Ref.

Descriptors: \*Rainfall, \*Flood control, Godavari Basin, India, Floods, Estimating, Mathematical

The short duration rainfall estimates of less than 24 hrs are essential for the design of spillways, culverts, road and railways bridges over small and medium catchments. This is accomplished from ordinary non-recording raingauges estimates short duration extreme rainfall for given return periods. Using data of 14 randomly selected self recording raingauges (SRRGs) from an already existing net-work of 17 S.R. raingauges in lower Godavari basin, regression equations were filled between a short duration rainfall estimate and a 24 hour rainfall estimate for a given return period. The coeffi-cients of regression curve were worked out by the least squares method with the basin as a unit. Using these constants and coefficients, estimates of short duration in a problem area were made. The short duration rainfall estimates for 12 and 50 year return periods were computed for three existing SRRG stations which were not used in the computation of regression coefficients and four ordinary raingauge stations in and around the sub-zone. The errors, on comparison are within reasonable limits. The technique presented in the paper can be employed to estimate short duration rainfall from daily rainfall records for any area. (Baker-IVI) W84-01307

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DROUGHT SPELLS OVER NORTH-CENTRAL INDIA DURING THE L979 SOUTHWEST MONSOON,

Cochin Univ. (India). Dept. of Marine Sciences. H. S. Ram Mohan, P. Vaisala, and B. V. Appa

Mausam, Vol. 34, No. 3, p 299-302, July, 1983. 3 Fig. 1 Tab, 7 Ref.

Descriptors: \*Drought, India, Moisture deficiency, Vegetation, Jamshedpur, Seasonal variation, India Monsoons, Wind.

Widespread drought spells were noted over north-central India during the 1979 summer monsoon. An attempt is made to study the impact of drought conditions on the short period water balances of representative stations in the region. Cumulative deviation techniques were used to delineate and categorize the intensity and duration of drought spells. Ecologically, a mild drought of prolonged duration was more detrimental to vegetation than an intense drought of short duration. During the study period, there were prolonged drought spells of large and severe categories which were capable of crippling the economy of the region due to their adverse impact on agricultural production. The water balance procedure can be used to effectively delineate periods and intensities of droughts from an ecoclimate point of view. It is suggested that these techniques are more rational in delineating areas and periods of drought and categorizing their everities. (Baker-IVI) W84-03308

SEMI-QUANTITATIVE PRECIPITATION FORECASTS FOR GOMTI CATCHMENT BY SYNOPTIC ANALOGUE METHOD, Meteorological Office, Lucknow (India). J. Lal, J. S. Day, and K. K. Kapoor. Mausam, Vol. 34, No. 3, p 309-312, July, 1983. 1

Fig. 3 Tab, 4 Ref.

Descriptors: \*Precipitation, \*Forecasting, India, Gomti Catchment, Catchment areas, Rainfall, Rainfall distribution, Uttar Pradesh, Rainstorms.

At present, reasonably accurate qualitative rainfall forecasts for areas of interest can be given 24 to 28 hrs in advance, though for hydrological forecast-ing, these do not serve the real purpose since quantitative precipitation forecasts are required for rainfall run-off relationships. A simple method was sought for the semiquantitative advance assessment of areal rainfall for the Gomti river catchment in Uttar Pradesh. Different types of synoptic situa-tions are correlated with their resulting rainstorms over the catchment to prepare synoptic analogues for forecasting the range of areal rainfall. If the assessment of the synoptic situation can be made correctly with the available data at the time the forecast is issued and the direction of movement of the rainstorm producing weather systems can be predicted on the basis of all available meteorological information, then semi-quantitative precipita-tion forecasts can be made fairly accurately 24 hr in advance using the analogues for the Gomti catchment as given. Similar analogues can be determined in respect to other river catchments.
(Baker-IVI) W84-03309

BASIN PRECIPITATION ESTIMATES BY BETHLAHMY'S TWO-AXIS METHOD, California State Univ., Northridge. Dept. of Geog-

A. Court, and M. T. Bare

Journal of Hydrology, Vol. 68, p 149-158, 1984. 3 Fig. 3 Tab, 12 Ref.

Descriptors: \*Precipitation, \*Bethlahmy's two-axis method, Hydrology, Climatology, Mathematical studies, Thiessen polygons, Isohyets, Isohyet planimetry, Elevation, Numerical analysis, Raingages, Depth-area-duration analysis.

Annual precipitation during each of five years over each of eight U. S. river basins, 800-4200 sq km, was estimated by Bethlahmy's two-axis method, was estimated by Bethlahmy's two-axis method, Thiessen polygons, Isohyet planimetry, elevation weighting and simple averages. Elevation weighting had the largest values, isohyetal computations the smallest. Straight averages were sometimes high, sometimes low. Estimates from Thiessen polygons and the two-axis method tended to be in the middle of the estimates more so for the twothe middle of the estimates more so for the two-axis method. When gages are numerous and rather evenly spaced throughout a basin, the direct aver-age of their annual catches is an adequate estimate of yearly basin precipitation. Bethlamy's two-axis method agreed with the other methods, but were easier to compute than by Thiessen polygons. The two-axis method requires identification of the cir-cumcircle diameter, construction of two perpen-dicular bisectors, and measurement of angles. (Murphy-IVI) W84-03341

ANALYSIS AND MODELING OF PALMER'S DROUGHT INDEX SERIES,

Purdue Univ., Lafayette, IN. School of Civil Engi-A. R. Rao, and G. Padmanabhan

S. R. Rao, and G. Padmanabhan. Journal of Hydrology, Vol. 68, p 211-219, 1984. 12 Fig, 7 Tab, 18 Ref.

Descriptors: \*Drought, \*Stochastic models, Model studies, Mathematical equations, Palmer's drought index, Kansas, Iowa, Forecasting, Rainfall.

The stochastic nature of yearly and monthly Palmer's drought index (PDI) series was investigated and characterized via valid stochastic models which may be used to forecast and simulate the PDI series. The monthly and annual PDI series for lowa (1930-1962) and Kansas (1887-1962) are analyzed. The analysis of the PDI series indicates that long term oscillations and high persistence structure are important characteristics of drought indices and hence of droughts. The periodic behavior in drought index series is apparent in the conventional power spectra and also in the spectra computed by using high-resolution spectral methods. Rescaled range-lag characteristics also support these conclusions. Even so, the PDI series can be modeled by simple stochastic models which premodeled by simple stochastic models which pre-serve the important statistical characteristics of the serve the important statistical characteristics of the original data as demonstrated in this study. The simple models of PDI series developed can be used for generating synthetic PDI data and for foreast ing PDI values which are used in agricultural planning and optimal operation of irrigation sys-tems, respectively. (Baker-IVI) W84-03344

A STOCHASTIC MODEL FOR A SMALL-TIME-INTERVAL-INTERMITTENT HYDRO-LOGIC PROCESS

Missouri Univ.-Rolla. Dept. of Civil Engineering. C. D. Morris. Journal of Hydrology, Vol. 68, p 247-272, 1984. 7 Fig, 8 Tab, 4 Ref.

Descriptors: \*Stochastic models, \*Precipitation, Rainfall, Model studies, Markovian precipitation distribution, Boneyard Creek, Morrow plots.

One of the major problems facing hydrologists is the lack of lang-term records of precipitation and streamflow. Simulation of hydrologic records by means of stochastic modeling is a commonly ac-cepted statistical procedure to extend the record. A methodology is developed for the generation of intermittent small-time-interval (15 min) precipitation. The methodology consists of three components: a probabilistic wet-and-dry sequence component; a Markovian precipitation distribution component; and a regressive spatial-distribution com-ponent. The method is demonstrated by applicaponent. The method is demonstrated by application to an actual precipitation network, the Bon-eyard Creek raingage network in Champaign-Urbana, Illinois. The trend in frequency of precipitation amounts from the 89 yr Morrow plots data are produced by the model using 13 yr of historical data. The model reproduces the mean and variance of storm precipitations, the storm lengths, the dry-period lengths, the transition probability distributions of the precipitations and the autocorrelation structure of the network data. (Baker-IVI) W84-03346

RECENT DEVELOPMENTS ON THE PROBA-BLE MAXIMUM PRECIPITATION (PMP) ES-TIMATION IN CHINA, East China Technical Univ. of Water Resources,

Nanjing, Dept. of Hydrology. Z. Daojiang, and Z. Jinshang. Journal of Hydrology, Vol. 68, p 285-293, 1984. 4 Fig. 1 Tab, 8 Ref.

Descriptors: \*Precipitation, \*Estimating, China, Seasonal variation, Storms, Flood control, Probable maximum precipitation, Design criteria, Construction, Earth dams, Spillways, Reservoirs.

China is situated at the east of the Asian continent and in the subtropical and northern temperate zone of the Asian continental monsoon climate. Regional and seasonal characteristics of rain storms in China which introduce the most intensive rainfall

#### Snow, Ice, and Frost-Group 2C

occurrences are examined. The techniques and practices involved in estimating the probable maximum precipitation from these storms is reviewed. Due to the lack of adequate streamflow data and abundance of heavy storms in China, it is very difficult and dubious to extrapolate a frequency curve to the long return periods required for a spillway of a major structure. In the design critespillway of a major structure. In the design criterion of earth dams and/or rockfill dams (embankment) for reservoirs of major significance and also for important small dams the probable maximum precipitation and probable maximum flood should be used. Generalized charts of 24 hr point PMP have been developed. (Baker-IVI) W84-03347

FOCUSING MECHANISMS IN THE TEXAS HILL COUNTRY FLASH FLOODS IN 1978,

National Oceanic and Atmospheric Administra-tion, Boulder, CO. Environmental Research Labs. F. Caracena, and J. M. Fritsch. Monthly Weather Review, Vol. 111, No. 12, p 2319-2332, December, 1983. 27 Fig. 19 Ref. USAF grant AFOSR-79-0125.

Descriptors: \*Focusing mechanisms, \*Texas, \*Hill Country, \*Flash floods, Air masses, Storms, Thunderstorms, Rainfall intensity, Runoff volume.

During the early morning of 2 August 1978, a stationary thunderstorm complex drenched the Balcones Escarpment of Texas and unleashed flash floods in the Hill Country which killed 27 people and produced extensive damage. After the storm, an unofficial 24 h total of at least 79 cm of rain was erved near the town of Bluff (about 90 km northwest of San Antonio). Five distinct mechanisms or meteorological features interacted to focus and anchor the storm complex. An east-west oriented mesohigh outflow boundary was situated just south of the storm area while a rapidly moving ribbon of extremely moist boundary-layer air flowed toward the storm area from the southeast. An elevated warm, dry layer of air extended over the area east of the Hill Country and capped the southeasterly low level inflow. A deep vert motion field associated with a midtroposph short-wave trough advanced toward the Hill Country from Mexico, and the diurnal heating cycle with its associated production of thermally forced convective clouds ended. The juxtaposition on the first four mechanisms over the storm area in combination with terrain lifting and the termination of convection initiated by boundary layer heating resulted in a forced, stationary storm complex that produced catastrophic flash floods in the Hill Country. (Murphy-IVI) W84-03364

WATER POLLUTION ARISING FROM SOLID WASTE (COAL, FLY ASH, SLAG) DISPOSAL, AND MEASURES TO PREVENT WATER POL-

Electric Power Research Inst., Palo Alto, CA. D. M. Golden.

ater Science and Technology, Vol. 15, No. 11, p 1-10, 1983. 10 Tab, 16 Ref.

Descriptors: \*Water pollution prevention, \*Waste disposal, Coal, Fly ash, Slag, Utilities, Environmental effects, Phytotoxicity, Groundwater pollu-

At the present, the annual world combustion of coal in electric power plants is about 2450 million metric tons coal eqv., resulting in the precipitation of 250-300 million tons of fly ash. Potential interactions of the environment with land-disposed utility coal to the company of the environment with land-disposed utility effects. wastes include: effects on local air quality, effects wastes include: effects on local air quality, effects on soils and vegetation, phytotoxicity, groundwater effects, effects on surface waters, and disposal site washout. Both natural and engineered mitigating mechanisms are reviewed. These wastes are generally regulated as non-hazardous waste in the United States. Nevertheless, it is possible for non-hazardous waste to cause significant groundwater contamination. It is necessary for utility designers to consider the environmental risks and potential for liability when making engineering/cost evaluafor liability when making engineering/cost evalua-tions of waste disposal options. (Baker-IVI) W84-03372

THE METEOROLOGICAL OFFICE RAINFALL AND EVAPORATION CALCULATION SYSTEM - MORECS, M. Field.

Agricultural Water Management, Vol. 6, No. 2/3, p 297-306, 1983. 4 Fig. 1 Tab, 8 Ref.

Descriptors: \*Rainfall, \*Evaporation, Soil water, Permeability, Winds, Temperature, Vapor pres-sure, Soil moisture deficiency, Water loss.

MORECS is an operational system using a suite of computer programs which has as its output esti-mates of soil moisture deficit, evapotranspiration and hydrologically effective rainfall plus several meteorological elements in the form of averages over 40 x 40 km grid squares superimposed over Great Britain. The output is disseminated to a wide Great Britain. The output is disseminated to a wide range of customers on the day that MORECS is run. The operational system is described in two stages: meteorological data collection/storage, and data manipulation. Meteorological elements used by MORECS include rainfall, sunshine, windspeed, temperature, and vapor pressure. (Baker-IVI) W84-03442

INFRARED REMOTE SENSING FOR MONI-

INFRARED REMOTE SENSING FOR MONITORING RAINFALL, EROS Data Center, Sious Falls, SD. D. G. Moore, J. C. Harlan, J. L. Heilman, D. O. Ohlen, and W. D. Rosenthal. Agricultural Water Management, Vol. 7, No. 1-3, p 363-378, 1983. 7 Fig. 15 Ref. National Oceanic and Atmospheric Administration grant NA 80 AA-D-0032. Geological Survey contract 14-08-0001-20129.

Descriptors: \*Monitoring, \*Rainfall, sensing, Precipitation, Spatial distribution, Soil water, TIROS-N, Satellite technology, Weather satellites, Infrared imagery.

Evaluations of thermal infrared satellite data from TIROS-N and the Heat Capacity Mapping Mission showed that rainfall distribution patterns could be showed that rainfall distribution patterns could be reliably detected on images acquired up to at least 3 days after the event. The temperature relationship decreased 8 days after the event when soil variations influenced the signal. A time-series analysis reduced thermal variability normally observed over diverse landscapes and increased the sensitiviover diverse landscapes and increased the sensitivity of the procedures. The method of repetitive low-resolution thermal observations could be operationally employed over large geographic regions with currently available satellite systems. The results would augment the existing raingauge stations by increasing the spatial sensitivity and the reliability of detection and mapping individual rainfall events. (Baker-IVI) W84-03455

DISTRIBUTION OF MEAN ANNUAL PRE-CIPITATION ACROSS SOME STEEPLAND REGIONS OF NEW ZEALAND, Ministry of Works and Development, Christ-church (New Zealand). Water and Soil Div. G. A. Griffiths, and M. J. McSaveney. New Zealand Journal of Science, Vol. 26, No. 2, p 197-209, 1983. 7 Fig, 2 Tab, 13 Ref.

Descriptors: \*Precipitation, \*Annual distribution, New Zealand, Rainfall, Spatial distribution, Moun-tains, Mathematical models, Tararua Range, Kaweka Range, Mt. Egmont, Hunua Range, Wai-takere Range, Model studies.

The spacial density of raingauges in lowland regions of New Zealand generally is adequate to define the position of isohyets on the 1:500 000 scale maps. But in steepland or highland areas, expecially those exceeding 1000 m in altitude, rainexpecially those exceeding 1000 m in altitude, rain-fall information is sparse, and position of isohyets unreliable. The position of maximum rainfall coin-cides approximately with the crest of the principal ridge. On both flanks of a range, rainfall distribu-tion is a well-defined function of ground elevation and also of horizontal distance from ridge crest. Ranges are distinguished into two types according to whether the elevation of their principal ridge crest is less or greater than 1300 m. For the former

type rainfall gradient with respect to elevation at ridge creat is a positive increasing function of creat altitude, and for the latter type a positive decreasing function. A quantitative non-linear model describing a single-valued relation between rainfall and elevation at ridge crests and calibrated by data from 6 New Zealand ranges has high precision and the status of a structural relation. An extension to the model defines a single-valued relationship between rainfall and elevation for a given transect but is multiple-valued otherwise. Repeated application of the model and its extension to a steepland region allows improved construction of rainfall isohyets. (Baker-IVI) type rainfall gradient with respect to elevation at

PHYSICALLY MEANINGFUL PARAMETERS THAT CHARACTERISE RAINFALL TOTALS AND RAINFALL EXTREMES, Meteorological Service, Wellington (New Zea-

K. J. A. Revfeim, and H. S. Hughes

New Zealand Journal of Science, Vol. 26, No. 4, p 443-445, 1983. 2 Tab, 5 Ref.

Descriptors: \*Rainfall distribution, Poisson ratio, Mathematical studies, Precipitation, Storms, Sea sonal variation, Distribution, Rainfall intensity.

easonal patterns of total rainfall and extreme rain-Seasonal patterns of total rainfall and extreme rain-fall events can be described in terms of physically meaningful parameters. The physical parameteriza-tion of rainfall data will distinguish between re-gions having the same mean rainfall but where one region has few events of large average amounts and another region has significantly more events of smaller average amount. Characterization of rain by parameters of a Poisson process of event occur-erce and of an independent distribution of event rence and of an independent distribution of event size provides a better basis for comparison between sites or regions than the empirical statistical char-acteristics commonly used. (Baker-IVI) W84-03487

#### 2C. Snow, Ice, and Frost

COMMENTS CONCERNING 'CONVECTION PATTERNS IN A POND', Hawaii Univ., Honolulu. Dept. of Oceanography. A. H. Woodcock, R. B. Lukas, and K. B. Katsaros. Bulletin of the American Meteorological Society, Vol. 64, No, 3, p 274-279, March, 1983. 4 Fig, 11

Descriptors: \*Ice formation, \*Albedo, \*Snowmelt, \*Temperature effects, \*Convection, Ice, Ice water interfaces, Iced lakes, Ice cover, Snow cover,

The article on 'Convection Patterns in a Pond' by K. B. Katsaros, Bulletin of the American Meteorological Society, Vol. 62, pp 1446-1453, 1981, stimulated the current authors to give further thought to their own and others' previous observations on this subject and specifically on direct and indirect convection effects. The weight of snowfall on ice-covered shallow ponds frequently causes upwell-ing of pond waters through leaks in the ice cover. The overall effect produced by dendritic melt cen-The overall effect produced by dendritic melt centers surrounded by the patterned arrangement of altered albedo in the ice and snow on the pond suggests a pattern caused directly by differential melting of the ice and snow cellular convection from below. This pattern is also observed from plant stems projecting through the ice near shore, from openings along the shoreline, and from holes drilled in ice for experimental purposes. If the upwelling water temperature is too low for convection to occur in the water above the ice, then circular areas of melt and albedo changes might occur. The occasional regularity in the distribution of these patterns reveals the indirect role of convection cells in the water below the ice. (Geiger-FRC) FRC) W84-02981

MICROCLIMATE AT ARCTIC TREE LINE 3, THE EFFECTS OF REGIONAL ADVECTION

#### Group 2C-Snow, Ice, and Frost

ON THE SURFACE ENERGY BALANCE OF

UPLAND TUNDRA, McMaster Univ., Hamilton (Ontario). Dept. of Geography. W. R. Rouse.

Water Resources Research, Vol. 20, No. 1, p 74-78, January, 1984. 2 Fig. 3 Tab, 7 Ref.

Descriptors: \*Energy, \*Advection, Heat flow, Tundra, Physical properties, Heat balance, Hudson Bay, Bays, Winds, Radiation, Climates, Frozen

Energy balance components of net radiation, ground heat flux, and latent and sensible heat fluxes for upland tundra near the Hudson Bay coast at Churchill were measured continuously coast at Churchii were measured continuously between April 25 and September 6, 1979. The measurements indicate a strong regional advective effect. In the postmelt period with cold onshore winds, which at Churchill blow from the north, whos, which at Churchiii bow from the north, sensible heating of the atmosphere was large, and heating of the ground was suppressed. For offshore winds from the south, ground heating was large and atmospheric heating suppressed. The net radiation and latent heat flux were little affected by radiation and latent heat flux were little affected by wind direction. An atmosphere warming therefore should lead to a strongly increased ground warming by reducing the longevity of the Hudson Bay ice. It is also possible that the same advective factors that affect open tundra will also influence the forest at tree line, although at present no measurements of the atmospheric fluxes are available to support this thought. (Baker-IVI) W84-03413

TRANSPORT OF WATER IN FROZEN SOIL. II. EFFECTS OF ICE ON THE TRANSPORT OF WATER UNDER ISOTHERMAL CONDI-TIONS

Cold Regions Research and Engineering Lab., Hanover, NH.

For primary bibliographic entry see Field 2G. W84-03458

CLIMATIC EFFECTS ON THE RECESSION OF CLIMATIC EFFECTS OF THE RANZ JOSEF GLACIER,
Meteorological Service, Wellington (New Zea-

W. D. Hessell. New Zealand Journal of Science, Vol. 26, No. 2, p 315-320, 1983. 3 Fig, 3 Tab, 6 Ref.

Descriptors: \*Glaciology, \*Climatology, Glaciers, New Zealand, Recession, Snowfall, Rainfall, Tem-perature effects, Franz Josef Glacier, Meteorology.

Investigations of sequences of meteorological parameters observed over extensive periods on the West Coast of New Zealand have been compared with observations of the recession of the Franz Josef Glacier terminus. Independent investigations of the time series of precipitation, pressure gradient, and temperature have shown that prior to 1930, 3 years before the Glacier terminus commenced major recession, the 2 former parameters were significantly greater than in later years but that there has been no statistically significant increase in ambient temperature in the West Coast crease in amoient temperature in the West Coast region. A depletion in the ice accumulation rate since 1930 has been the primary cause of the glacial recess there, and all glaciers with neves near the main divide, including those flowing eastward, have been affected. Temperature, precipitation, and other parameters such as radiation are not trally independent and during regions of near totally independent and during periods of near constant precipitation, short-period temperature constant precipitation, snort-period temperature anomalies may affect retreat rates of depleted glaciers. A significant advance of the Glacier could commence in 1983 or 1984 particularly in view of the heavy snowfalls in the springs of 1980, 81, and 82 and the wet, cold summer of 1982-83 on the West Coast. (Baker-IVI) W84-03483

VARIATIONS OF THE STOCKING (TE WAE WAE) GLACIER, MOUNT COOK, AND CLI-MATIC RELATIONSHIPS,

University of East Anglia, Norwich (England). Climatic Research Unit. M. J. Salinger, M. J. Heine, and C. J. Burrows.

New Zealand Journal of Science, Vol. 26, No. 3, p 321-338, 1983. 15 Fig, 2 Tab, 26 Ref. DOE contract DE-ACO2-79EV10098.

Descriptors: \*Glaciers, \*Precipitation, \*Temperature, \*Stocking Glacier, \*New Zealand, Climate, Principal component analysis, Multiple regression

A chronology of the fluctuating positions of the terminus of the Stocking Glacier, from 1869 to 1978 A.D., was derived from photographs. The changes in the glacier over the periods 1914-1974 and 1930-1974 are related with climatic variables by means of principal component regressions. The strongest associations of glacier variations for each of the periods examined are with smoothed monthly temperatures and precipitation data, with a lag ly temperatures and precipitation data, with a lag of 2 and 5 years respectively. The similarity between each regression equations confirmed the sta-bility of the method and identified temperature parameters as the more important factors correlated with glacier variations. Variation in Stocking Glacier terminus behavior accounted for by the 2 models is 83 and 71% respectively. (Author's ab-W84-03484

#### 2D. Evaporation and Transpiration

DIRECT EVAPORATION FROM SOIL UNDER A ROW CROP CANOPY, A gricultural Research Service, Akron, CO. R. W. Shawcroft, and H. R. Gardner.

Agricultural Meteorology, Vol. 28, No. 3, p 229-238, 1983. 4 Fig. 15 Ref.

Descriptors: \*Evaporation, \*Soil moisture, \*Canopy, Evapotranspiration, Mathematical equations, Lysimeters, Drainage, Flow, Surface water, Transpiration, Lysimeters

Accurate measurements of soil evaporation under plant canopies are needed to refine the treatment of plant canopies are needed to refine the treatment of soil-surface wetness in irrigation-scheduling programs. Small lysimeters placed under a crop canopy to measure the soil evaporation component of evapotranspiration were constructed of rigid PVC pipe sections, 20.3 cm in diameter, and 20, 10, or 5 cm long. Water loss from the lysimeters was measured gravimetrically from composite 1-cm-increment cores sampled daily. The results reported are for two drying cycles of 16 and 13 days in July 1975 and 1976. In order for the lysimeters to behave as the surrounding soil, the water content of the lysimeters must be higher than the soil outside to compensate for changes under the natural conditions due to plant uptake, drainage and ral conditions due to plant uptake, drainage and upward flow. Since the lysimeters depend on a set of compensating factors to directly measure E, estimates of E from them should be used with caution. A better use of the lysimeters would be to establish a relationship between lysimeter E and the surface soil water content and the use surface water content measurements to infer E. Several compensating errors must be involved in order for the lysimeters to simulate conditions of the actual soil surface. (Baker-IVI)
W84-03204

EVAPORATION FROM THE IRRIGATION WATER, FOLIAGE AND PANICLES OF PADDY RICE IN NORTH-EAST SRI LANKA, Institute of Hydrology, Wallingford (England). C. H. Batchelor, and J. Roberts. Agricultural Meterology, Vol. 29, No. 1, p 11-26, 1983. 12 Fig. 21 Ref.

Descriptors: \*Evaporation, \*Canopy, \*Vegetation effects, Plants, Evapotranspiration, Mathematical equations, Penman-Monteith equation, Rice, Transpiration, Panicles, Foliage, Irrigation water.

Fundamental to the design and operation of irriga-tion schemes is a knowledge of crop water use. The rate at which water is used by a particular crop is dependent on a number of factors which include age, variety, climate, soil-water availabil-ity, soil fertility, pests, diseases and cultivation, and irrigation practices. Combined measurements of

leaf and panicle conductances with meteorological data in the Penman-Monteith equation were used to estimate transpiration from a paddy rice canopy. Evaporation from the panicles and the irrigation water accounted for a significant part of total evaporation from the paddy fields. The Penman-crop factor method of estimating paddy rice water used agreed well with the independent estimates of evapotranspiration here reported. After heading, the transpiration from the panicles accounted for 27% of the total transpiration of the canopy. The total evaporation for the 1981 cropping season 27% of the total transpiration of the canopy. Ine total evaporation for the 1981 cropping season from transplanting to harvest was 64 mm, of which 188, 395, and 63 mm were evaporated from the irrigation water, foliage and panicles, respectively. (Baker-IVI)

EVAPORATION FROM SCREENED CLASS A PANS IN A SEMI-ARID CLIMATE,

Agricultural Research Service, Fresno, CA. Water Management Research Lab. T. A. Howell, C. J. Phene, D. W. Meek, and R. J.

Miller. Agricultural Meteorology, Vol. 29, No. 2, p 111-124, 1983. 9 Fig, 3 Tab, 15 Ref.

Descriptors: \*Evaporation, \*Screens, Semiarid lands, Water loss, Evapotranspiration, California, Climates.

Evaporation measurements from screened and standard Class A pans at two locations near Fresno, California were compared together and with potential evaportanspiration estimates, using two combination equations with climate data from the sites. The screen covering reduced the evaporation by 10% in a semi-arid environment. The ration by 10% in a semi-arid environment. The evaporation reduction was largely attributed to differences in radiation interception by the screened pan. The evaporation from both type pans was highly correlated to potential evaportanspiration (ETO) estimates by the Penman and Van Bavel equations. Average annual pan coefficients for the open Class A pan were 0.81 and 0.91 for the screened Class A pan using the Penman equation calculations. Both pan coefficients were shown to exhibit a strong cyclical annual trend. When installed in standard grass weather station environments with adequate maintenance, evaporation pans can reliably estimate ETO, especially if the pan evaporation is averaged for time periods over 7 days. The screen covering served as a major obstacle to non-evaporative water losses from obstacle to non-evaporative water losses from birds and animals commonly found at less protected sites, but the screen covering did not improve the correlations with potential evapotranspiration calculations. (Baker-IVI)

THE DIRECT EFFECT OF SHELTER ON EVAPORATION RATES: THEORY AND AN EXPERIMENTAL TEST,

Department of Scientific and Industrial Research, Palmerston North (New Zealand). Div. of Plant Physiology.
K. G. McNaughton.

Agricultural Meteorology, Vol. 29, No. 2, p 125-136, 1983. 2 Tab, 13 Ref.

Descriptors: \*Evapotranspiration, \*Windbreaks, Evaporation, Water loss, Shelterbelts, Advection.

Evaporation has been shown in previous work to be most strongly reduced during periods of strong sensible-heat advection. From theoretical considerations the use of an exchange flux as the measure of the effect of advection is proposed. The experi-ment of Miller is re-analyzed in terms of this exchange flux. In Miller's experiment evaporation rates from soybeans were measured directly using lysimeters, and secondary changes in plant growth and stomatal resistances were minimized. The exchange flux from Miller's lysimeter, located near the center of a semi-circular windbreak, was reduced to about half of its value in the open on most occasions. Thus the proposal that a windbreak can reduce the advective component of evaporation from a crop by reducing turbulent transport to the sheltered crop appears to be substantiated by theo-

#### **Evaporation and Transpiration—Group 2D**

retical and experimental evidence, if the advective component is identified as the exchange flux rather than the downward sensible heat flux. (Baker-IVI)

THEORETICAL AND MEASURED EVAPORA-TION RATES FROM AN EXPOSED PICHE AT-

MOGRAPH, Purdue Univ., Lafayette, IN. Dept. of Agronomy. K. T. Paw U, and M. Gueye. Agricultural Meteorology, Vol. 30, No. 1, p 1-11, 1983. 2 Fig. 5 Tab, 22 Ref. NSF Atmospheric Sciences Section grant ATM-8021075.

Descriptors: \*Evaporation, \*Evaporimeters, \*Measuring instruments, Energy budget, Temperature effects, Humidity, Wind speed, Radiation, Leaves, Water potential.

Evaporation and evapotranspiration influence the growth and even the survival of agronomic crops and livestock, forest species, and influence the water use strategies of human societies. A linearized energy budget for a leaf is used to predict the ized energy budget for a leat is used to predict the daily evaporation from a Piche atmograph. A one-to-one relationship was noted with observed evaporation, and accounted for 70-90% of the observed variance. Successful predictions were possible even when the meteorological data were taken at 12 hr intervals, although the most accurate predictions were based on data taken at 1 hr intervals. some vere cased on tast attent at 1 in intervals. Sensitivity analysis predicts that Piche evaporation is strongly affected by air temperature, relative humidity, wind speed and long-wave radiation; albedo and short-wave radiation had lesser effects. albedo and short-wave radiation had lesser effects. The present study supports the idea that the Piche atmograph models the potential evapotranspiration of an individual leaf. The Piche evaporimeters and atmographs may be good analogs for potential leaf evapotranspiration because the equations used for modeling the Piche were originally developed for modeling the Fiche were originally developed for leaves. The definition used for potential leaf evapo-transpiration is the evapotranspiration from a leaf when water is not limited, and when the physiological (mainly stomatal) resistance is effectively zero. (Baker-IVI) W84-03213

SEASONAL ESTIMATES OF TRANSPIRA-TION FROM A MILLET CROP USING A PO-

ROMETER, Nottingham Univ. (England). School of Agricul-

S. N. Azam-Ali Agricultural Meteorology, Vol. 30, No. 1, p 13-24, 1983. 5 Fig, 4 Tab, 19 Ref.

Descriptors: \*Transpiration, \*Measuring instru-ments, \*Crops, Millet, Porometer, Seasonal vari-ations, Africa, Stomatal transpiration, Leaves, Water loss, Soil-water-plant relationships.

Water is one of the main constraints to agricultural production in many areas of the world since plant growth is closely related to transpiration. In west Africa, three populations of millet were grown to assess how growth was related to population and water supply. Stomatal resistance was measured with a porometer 3 times a day on 14 days. Boundard or the supplementary of the supplem ary-layer resistance was estimated on the same days using blotting-paper replicas for the leaves, and wet- and dry-bulb thermocouples were used to determine concentration differences of water vapor. Changes in the mean rate of transpiration estimated from these quantities were strongly correlated with changes of green leaf area during the season. Seasonal changes of stomatal resistance were much less significant in determining the seasonal trend of transpiration rates. Estimates of sonal trend of transpiration rates. Estimates of water loss by transpiration agreed well with measurements of soil-water extraction obtained with a neutron moisture meter. This experiment suggests that the porometer is a useful alternative to the more established measurements of crop water use. Other useful information is obtained through the technique such as leaf temperature and vapor con-centration differences between the leaf and the air. One major drawback is the time and labor spent in the field and on subsequent analysis of the data collected. A microprocessor incorporated in the porometer would allow semi-automatic calibration and enable direct calculation of transpiration per unit area of leaf, thus encouraging greater use of this technique. (Baker-IVI) W84-03214

A DISCUSSION OF THE RELATIONSHIPS BE-TWEEN THE PRINCIPAL FORMS OF THE COMBINATION EQUATION FOR ESTIMAT-ING CROP EVAPORATION, Institute of Hydrology, Wallingford (England). I. B. Stewert

Agricultural Meteorology, Vol. 30, No. 2, p 111-127, 1983. 2 Tab, 26 Ref.

Descriptors: \*Evaporation, \*Vegetation, Forests, Canopy, Mathematical equations, Estimating.

To assist hydrologists and agronomists in estimating crop evaporation, the relationships between different forms of the combination equation are demonstrated by highlighting the assumptions used in their derivation and their data requirements. It is suggested that there is no formula which is superior in all situations. It is generally a compromise between data requirements and physical reality. By approaching the assumptions involved, an improved evaluation of the accuracy of the estimate of evaporation in each case can be made. Only the more complicated equation can give satisfactory estimates of the actual evaporation from all types of surfaces. For an area of low vegetation, which is rarely subject to significant soil moisture deficit, an estimate of the potential evaporation. For areas of low vegetation and low rainfall, an estimate of the potential can still be used as an index and upper limit to the actual evaporation. For other vegetatives to the second of the potential can still be used as an index and upper limit to the actual evaporation. For other vegetations which is the second of the potential can still be used as an index and upper limit to the actual evaporation. For other vegetatives to second of the potential evaporation. limit to the actual evaporation. For other vegeta-tion types, and for forests in particular, the useful-ness of an estimate of the potential evaporation is limited. If evaporation from a wet canopy is likely to be a sizeable component of the total evaporation, the potential evaporation may not even give a useful index of the actual evaporation. (Baker-IVI) w84-03217

WATER BALANCE OF THREE IRRIGATED CROPS ON FINE-TEXTURED SOILS OF THE RIVERINE PLAIN, Commonwealth Scientific and Industrial Research Organization, Griffith (Australia). Div. of Irriga-tion Passacian.

For primary bibliographic entry see Field 21. W84-03238

FIELD EVALUATION OF A WATER RELA-TIONS MODEL FOR SOYBEAN, I. VALIDITY OF SOME BASIS ASSUMPTIONS, For primary bibliographic entry see Field 2I. W84-03245

FIELD EVALUATION OF A WATER RELATIONS MODEL FOR SOYBEAN, II. DIURNAL FLUCTUATIONS, Florida Univ., Gainesville. Dept. of Agricultural

Engineering. bibliographic entry see Field 2I.

RESISTANCES TO EVAPOTRANSPIRATION FROM A ST. AUGUSTINEGRASS TURF CANOPY,

and M Univ., College Station. Dept. of Soil and Crop Sciences.
D. Johns, J. B. Beard, and C. H. M. van Bavel.
Agronomy Journal, Vol. 75, No. 3, p 419-422,
May-June, 1983. 3 Tab, 17 Ref.

Descriptors: \*Evapotranspiration, \*Turf grasses, Resistance networks, Stenotaphrum, Canopy, Sto-matal transpiration, Water potentials, Water con-servation, Air temperature, Dewpoint.

In St. Augustinegrass (Stenotaphrum secundatum) turf under adequately watered conditions, evaporanspiration was influenced to a greater extent by environmental factors which were external to the plants rather than by disposition of leaf stomata. Using an Ohm's law analogue to define a resistance

network for the turfgrass canopy, magnitudes of resistances to water loss were measured and com-pared. Internal resistance was defined as aggregate diffusive resistance of the foliage and was deterdiffusive resistance of the foliage and was determined from porometer measurements of diffusive resistance of leaves. External resistance was defined as the sum of aerodynamic resistance and resistance to air mass exchange within the canopy and was measured by three different methods. Internal resistance was only one-fourth to one-half the external resistance. Under wind speed conditions of 0.6 m/sec, actual evapotranspiration rates of St. Augustinegrass were only slightly lower than potential evapotranspiration rates. Chemical or genetic control of stomatal resistance would not result in appreciable savings of irrigation water.
(Wheatley-IVI)
W84-03247

LEAF AND CANOPY TEMPERATURES OF PEARL MILLET GENOTYPES UNDER IRRI-GATED AND NONIRRIGATED CONDITIONS, International Crops Research Inst. for the Semi-Arid Tropics, Patancheru (India). For primary bibliographic entry see Field 3F. W84-03251

INFLUENCE OF WATER STRESS ON THE DI-URNAL EXCHANGE OF MASS AND ENERGY BETWEEN THE ATMOSPHERE AND A SOY-BEAN CANOPY,

National Oceanic and Atmospheric Administra-tion, Oak Ridge, TN. Air Resources Atmospheric Turbulence and Diffusion Lab. For primary bibliographic entry see Field 2I. W84-03254

EFFECT OF FOLICOTE ANTITRANSPIRANT APPLICATION ON FIELD GRAIN YIELD OF MOISTURE-STRESSED CORN, New Mexico State Univ., Las Cruces For primary bibliographic entry see Field 3F. W84-03255

STRESS MEASUREMENT USING FOLIAGE TEMPERATURES,

Guelph Univ. (Ontario). Dept. of Land Resource

G. K. Walker, and J. L. Hatfield. Agronomy Journal, Vol. 47, p 623-629, July-August, 1983. 6 Fig, 2 Tab, 31 Ref. Univ. of California Agric. Exp. Stn. project 3462-H.

Descriptors: \*Water stress, \*Leaf temperatures, Stomata, Stomatal transpiration, Water deficit, Water vapor, Crop yield, Kidney beans, Moisture.

The total (stomatal and aerodynamic) conductance for water vapor of a crop (g sub v) reflects the rate of crop production. Determination of g should therefore be valuable in predicting crop yield. With an energy balance approach to crop stress assessment, foliage-air temperature differences (Tf - Ta) may provide a beans of determining g sub v. This study models the response of Tf - Ta to environmental parameters and conductances, and then, in a field experiment with kidney beans (Phaseolus vulgaris L.) grown under two radiation regimes, determines g sub v using measured Tf - Ta values, and relates this to crop yields. Kidney beans ('Red Kidney') were grown on deep Yolo clay loam (Typic Xerorthent) at Davis, Calif, under normal irradiance and with irradiance reduced by 50%. Different stress levels (different g The total (stomatal and aerodynamic) conductance under normal irradiance and with irradiance reduced by 50%. Different stress levels (different g sub v) were established by varying time and frequency of irrigation. Foliage temperatures (corrected for emissivity and sky radiation), net radiation and wet and dry bulb temperatures were recorded daily at 1/2 to 1 h after solar noon through most of the growing season. Seed yields were measured at the end of the season. In the energy balance model and field data Tf - Ta is sensitive to air saturation deficit (0.16C mb-1) and sensitive to air saturation deficit (0.16C mb-1) and to net radiation (0.5C/100 W m-2). Relative yields estimated as g sub v/g(max)sub v, with g(max) sub v determined from well-watered plots, agreed well with relative seed yields (r = 0.75). Major Tf - Ta responses to saturation deficit and net radiation

#### **Group 2D—Evaporation and Transpiration**

showed that Tf based crop stress estimates will not relate well to crop production unless these environmental parameters are accounted for, or unless they vary little between times of measurement. By using the energy balance, Tf - Ta measurements can be related explicitly to g sub v and, thereby, to crop production. (Murphy-IVI) W84-01257

EVAPOTRANSPIRATION AND YIELD ESTI-MATION OF SPRING WHEAT FROM CANOPY TEMPERATURE,

Arizona Univ., Tucson. Dept. of Soils, Water and Engineering.

R. A. Diaz, A. D. Matthias, and R. J. Hanks. Agronomy Journal, Vol. 75, p 805-810, September-October, 1983. 5 Fig, 2 Tab, 21 Ref.

Descriptors: \*Evapotranspiration, \*Wheat, \*Crop yield, \*Canopy, \*Temperature, Water stress, Plant water potential, Water management.

Canopy temperature indices are related to evapotranspiration (ET) and grain yield (Y) for many crops at various locations. Irrigation-water management methods have recently been proposed which involve the use of remotely sensed crop canopy temperature to assess actual crop water needs on a real-time basis. this study evaluates three indices at a location different from where the indices were developed. The indices were indices in its canopie (CWSI), and were tested at Logan, Utah on spring wheat (Triticum aestivum L. var. Fieldwin). Planting dates were 14. Apr., 28 Apr., and 19 May 1980. Canopy temperatures in differentially irrigated plots (36 X 3 m) were measured by infrared thermometry at midday from growth stages of heading to maturity. Net radiation, wind speed, humidity, and air temperature data were collected. Neutron meter measurements were used to calculate ET. Summations of SDD and summations of TSD and mean values of CWSI were calculated. Linear regression analysis for each planting showed large goodness of fit (r squared > or = to 0.93) for Et vs. summations of SDD (r squared > or = to 0.93) for Et vs. summations of TSD and V vs. summations of SDD data to 0.21 for the Y vs. summations of TSD and V vs. summations of SDD data to 0.21 for the Y vs. summations of TSD and to 0.21 for the Y vs. summations of TSD and to 0.21 for the Y vs. summations of TSD data. Slopes and intercepts of individual regression lines were significantly (alpha = 0.05) different. Goodness of fit of relative ET deficit with mean CWSI, r squared = 0.78. Results indicate that SDD may be most suitable for wheat yield assessment and water management

TURFGRASS EVAPOTRANSPIRATION, I. FACTORS INFLUENCING RATE IN URBAN ENVIRONMENTS,

Colorado State Univ., Fort Collins.
C. M. Feldhake, R. E. Danielson, and J. D. Butler.
Agronomy Journal, Vol. 75, p 824-830, September-October, 1983. 9 Fig. 3 Tab, 13 Ref.

Descriptors: \*Turfgrass, \*Evapotranspiration, \*Evaporation rate, \*Urban areas, Water management, Poa, Festuca, Cynodon, Buchloe, Lysimeter, Shade, Nitrogen, Water use, Moisture, Plant water potential.

Evapotranspiration (ET) by turfgrass in urban environment is site specific and can vary considerably from what would be predicted from regional climate. A large degree of heterogeniety exists in residential microclimate and lawn management practices. The relative importance of these factors needs evaluation to aid in planning for efficient use of municipal water, half of which is applied to lawns in some western areas. This study, using small lysimeters, evaluated the relative effects of mowing height, N fertility, shading, grass species, and soil composition on ET. Kentucky bluegrass (Poa pratensis L. var. 'Merion') mowed 5 cm used

15% more water than grass mowed at 2 cm. Thirteen percent more water was used when 4 kg/1000sq m of N was applied each month during spring and summer compared to only one application for the season, applied in the spring. Evapotranspiration by grass in 1979 was essentially the same whether growing on a clay soil or on a sand-peat mixture; however, a 6% decrease occurred for the soil system in 1980. Evapotranspiration increased linearly with solar radiation when an advective component of energy, accounting for 35% of ET, was subtracted from all solar treatments. Kentucky bluegrass and tall fescue (Festuca arundinacea Schreb. var. 'Rebel') which are cool-season grasses, used over 20% more water than bermudagrass. (Cynodon dactylon L. X Cynodon transvaalensis Davy var. Tifway') and buffalograss (Buchloe dactyloides Nutt) which are warmseason grasses. (Author's abstract)

RELATIONSHIPS BETWEEN LEAF WATER POTENTIAL, CANOPY TEMPERATURE, AND EVAPOTRANSPIRATION IN IRRIGATED AND NONIRRIGATED ALFALFA,

Minnesota Univ., St. Paul. B. S. Sharratt, D. C. Reicosky, S. B. Idso, and D. G. Baker.

Agronomy Journal, Vol. 75, p 891-894, November-December, 1983. 4 Fig, 19 Ref.

Descriptors: \*Leaves, \*Canopy, \*Temperature, \*Evapotranspiration, \*Irrigation effects, \*Alfalfa, Water use, Plant water potential, Moisture deficiency, Moisture uptake.

A prerequisite to exploiting potential production of any crop is to accumulate a knowledge of plant responses, whether the response is to climate, fertilizer, or water. Evaluations during the daytime were on a Waukegan silt loam soil (fine-silty over sandy or sandy skeletal, mixed, mesic Typic Hapludolls) with stress differences between irrigated and nonirrigated alfalfa (Medicago sativa L.). Canopy temperature (CT), evapotranspiration (ET), and leaf water potential (psi l), served as indicators of stress and were measured using an infrared thermometer, portable chamber, and pressure chamber, respectively. Canopy temperature and ET did not differ appreciably between irrigated and nonirrigated alfalfa in early morning, but after 0900 h and throughout the afternoon nonirrigated alfalfa had a higher CT and lower ET. Leaf water potential of nonirrigated alfalfa was consistently lower during the day. The maximum difference in CT, ET, and psi l between irrigated and nonirrigated alfalfa occurred at 1500 h where they equalled 2 degrees C, 0.2 mm/h, and 0.7 MPa, respectively. These stress differences reflected the differences in the plant available water of 280 and 60 mm (corresponding to 117 and 25% of extractable water) in the 1.83-m soil profile of the irrigated and nonirrigated plots, respectively. Nonirrigated alfalfa cat a faster rate as the peak stress period (1500 h) was approached; however, after this period a faster rehydration was observed for this treatment, as indicated by the relationship between CT and ET indicated a larger rate of change in CT prior to the leak stress period for nonirrigated as compared to irrigated alfalfa. After this time and until 1700 h, CT remained constant as ET decreased, indicating a decreasing ratio between ET and net radiation and thus greater restrictions on water movement through the plant, a direct cause of the hysteresis observed. (Murphy-IVI)

ALFALFA RESPONSE TO SOIL WATER DEFI-CITS. II. PLANT WATER POTENTIAL, LEAF CONDUCTANCE, AND CANOPY TEMPERA-TURE RELATIONSHIPS,

Minnesota Univ., St. Paul. Dept. of Agronomy and Plant Genetics.

Panti Geneusca, P. R. Carter, and C. C. Sheaffer. Crop Science, Vol. 23, No. 4, p 676-680, July-August, 1983. 3 Fig. 2 Tab, 26 Ref. OWRT, USDI grant 14-34-0001-1236-B158 MINN.

Descriptors: \*Alfalfa, \*Soil moisture deficit, \*Plant water potential, \*Canopy, \*Temperature, Evapotranspiration, Irrigation, Stomatal transpiration, Water stress.

Information is needed on the regulation of water vapor loss and on the plant water status of alfalfacits. Our objective was to characterize diurnal and seasonal plant water potential (psi p), leaf conductance (GI), and canopy temperature (Tc) relationships for field-grown alfalfa. Measurements of psi p, GI and Tc were made hourly from sunrise to sunset on 13 clear days from 10 July to 2 October on alfalfa subjected to a range of soil water levels during vegetative, bud, and bloom growth stages. Plant water potentials of well-watered plants were -0.1 to -0.4 MPa at sunrise and declined to -0.8 to -1.2 MPa at midday. With soil water depletions, psi p declined rapidly (0.08 to 0.4 MPa/day) and diurnal psi p cycling continued. Under severe plant water stress psi p were below -2.0 and -4.5 MPa at sunrise and midday, respectively. The GI under high moisture conditions reached a peak of up to 0.033 m/s at midmorning and decreased gradually until sunset. At moderate plant water deficits, GI was greatest during low transpirational demand periods (early morning and late afternoon) and depressed at midday. Under extreme plant water stress, GI remained at low levels (0.001 to 0.003 m/s) the entire day. Stomatal closure at midday resulted in Tc up to 8.5 degrees C higher for water-stressed ys. well-watered alfalfa. Leaf conductance declined linearly with decreasing psi p until psi p reached -2.5 MPa. Below a psi p of -2.5 MPa, GI stabilized at low levels. Regression coefficients (slopes) of the GI vs. psi p of -2.5 MPa, Blow a psi p of -2.5 MPa and decreased as MAT declined. Under nonlimiting soil moisture conditions, GI declined linearly Tc was reduced. Growth stage and daily pan evaporation did not influence the GI - psi p relationship. (Author's abstract)

SIGNIFICANCE OF ACCELERATED LEAF SE-NESCENCE AT LOW WATER POTENTIALS FOR WATER LOSS AND GRAIN YIELD IN MAIZE,

Navarra Univ., Pamplona (Spain). Dept. Fisiologia Vegetal.

For primary bibliographic entry see Field 2I. W84-03285

BIOMASS PRODUCTION IN WHEAT IN RE-LATION TO EVAPORATIVE DEMAND AND AMBIENT TEMPERATURE,

ANABENT TEMFERATURE, Indian Agricultural Research Inst., New Delhi. Div. of Agricultural Physics. N. V. K. Chakravarty, and P. S. N. Sastry. Mausam, Vol. 34, No. 3, p 323-326, July, 1983. 2 Tab, 7 Ref.

Descriptors: \*Evaporation, \*Irrigation, Wheat, Crop production, Biomass, Ambient temperature,

Biomass production in three varieties of wheat grown under irrigated field conditions was linearly related to cumulative evaporation and accumulated heat units above a certain threshold value. The intercepts for biomass production evaluated from the regression showed that about 35 days are needed for crop establishment for the linear relationship to be true between biomass and cumulative evaporation/accumulated heat, corresponding to 82 mm of evaporation and 497 degree days respectively. Biomass production estimates at different levels of cumulative evaporation and accumulated heat indicated the possibility of using the regressions for relative assessment of varietal response to prevailing atmospheric demand representing potential water requirements and the prevailing thermal regime which should prove useful as an additional tool in crop planning. (Baker-IVI)

#### Streamflow and Runoff-Group 2E

A SENSITIVITY ANALYSIS OF A NUMERI-CAL MODEL FOR ESTIMATING EVAPO-

CAL MODEL FOR ESTIMATING EVALUATION TRANSPIRATION, SAR, Inc., Riverdale, MD. P. J. Camillo, and R. J. Gurney. Water Resources Research, Vol. 20, No. 1, p 105-112, January, 1984. 9 Fig, 2 Tab, 11 Ref, 1 Append.

Descriptors: \*Evapotranspiration, \*Mathematical models, \*Evaporation, Weather, Energy, Simulation, Sensitivity analysis, Wheat, Soil water.

A simulation approach has been used to study the sensitivity of evaporation, estimated with an energy and moisture balance model, to the meteorological data used to drive the model. The numeri-cal model solves the surface energy balance equa-tion. Daily evaporation is calculated by integrating the instantaneous fluxes. A Monte Carlo method is used to apply random errors to the meteorological data, and constant biases are also applied. This was done for both bare and wheat fields. Previous data, and comsain obsess are also applied. In swas sensitivity studies have used analytical methods, ignoring the interaction of the meteorological measurements, their biases, and the feedback mechanisms which couple the energy and moisture fluxes. The method described here removes these restrictions and does not require linearity and differentiability in the evaporation estimation technique. The numerical method was shown to produce results generally similar to those expected analytically for random errors under near-potential conditions. Measurement biases produced larger errors in evaporation than random errors. The method will be applicable for dry conditions, where an analytical approach is not feasible. (Author's abstract)

MEASUREMENT OF EVAPORATION BY A VAPOR BUDGET TECHNIQUE, Clemson Univ., SC. Dept. of Civil Engineering. B. L. Sill, J. E. Fowler, and W. R. Lagarenne, Jr. Water Resources Research, Vol. 20, No. 1, p 147-152, January, 1984. 8 Fig. 8 Ref.

Descriptors: \*Evaporation, \*Vapor budget, \*Lake evaporation, Water vapor, Wind, Fetch, Water budget.

A vapor budget method for measuring evaporation from lakes is described. The technique involves measuring the upwind and downwind horizontal water vapor flux in the atmosphere for air that water vapor flux in the atmosphere for air that passes over an exposed water body. The difference in the two fluxes is shown to be equal to the surface evaporation. Instrumentation used to measure the required vertical profiles of horizontal velocity and water vapor density is also described. The method is applied on a small pond (57 x 57 m) in southern California, and measurements are compared with hourly water budget values of evapora tion. Despite the short fetch, which limits th tion. Despite the short fetch, which limits the thickness of the vapor layer, comparison of the vapor budget values and those obtained by the water budget method is favorable. Results from a limited number of measurements on a larger lake (with a 600-m fetch) are also presented. It is estimated that at the present state of development, the vapor budget method is accurate to approximately 20% for small- to medium-sized lakes. (Author's abstract) abstract) W84-03421

CROP WATER REQUIREMENTS FOR RAINFED AND IRRIGATED GRAIN CORN IN CHINA, California Univ., Los Angeles. Dept. of Geogra-

phy. W. H. Terjung, H.-Y. Ji, J. T. Hayes, P. A. O'Rourke, and P. E. Todhunter. Agricultural Water Management, Vol. 6, No. 1, p 43-64, 1983. 14 Fig. 2 Tab, 15 Ref.

Descriptors: \*Corn, \*Water use, \*Climate, \*China \*Korea, \*Evapotranspiration, Climate, Crop yield, Irrigation requirements, Model studies, Rainfall.

A basic parametric crop water use model (WATER) that employs climatic and environmental data to calculate temporal and spatial water

consumption for a variety of major crops was applied specifically for grain corn to the region of China and Korea to investigate the evapotranspiracomputed specifically for grain corn to the region of China and Korea to investigate the evapotranspiration (ET) demand on grain corn and the associated irrigation water applications necessary for optimal crop production. A network of 241 stations provided the seasonal climatic input. The climatic input consisted of data averaged over approximately a 20 year period. Among the results, highest ET under full irrigation (first harvest) occurred in the northwestern inland sections of China, whereas least ET was found for the southeast. Under rainfed conditions, the relationship became nearly inverse. In order to achieve optimum crop yields, about 1000 mm of irrigation water was needed in the northwest, contrasted with none required in the south and east of China. A sensitivity analysis was applied to determine the degree of error introduced by faulty or uncertain environmental input data. (Author's abstract)

THE METEOROLOGICAL OFFICE RAINFALL AND EVAPORATION CALCULAT SYSTEM - MORECS, For primary bibliographic entry see Field 2B. W84-0342 CALCULATION

A PRELIMINARY STUDY ON SCHEDULING IRRIGATION WITH CAN EVAPORIMETERS, Andhra Pradesh Agricultural Univ., Hyderabad (India), Agricultural Research Inst.
M. Govind Reddy, Y. Yogeswara Rao, K. Subba Rao, and K. Ramaseshaiah.
Agricultural Water Management, Vol. 6, No. 4, p 403-407, 1983. 5 Tab, 3 Ref.

Descriptors: \*Irrigation scheduling, \*Evaporators, Irrigation efficiency, Wheat, Corn, Can evaporators, Hyerabad, India.

One of the most effective ways of increasing irrigation efficiency would be to provide farmers with a simple tool to schedule irrigation. Use of a class A pan by farmers is not practicable, but simpler evaporators, such as 'can' evaporators, may be useful. Field experiments were conducted in Hyerabad, India to study the relationship between a standard class A pan and a simple 'can' evaporator and to suggest irrigation scheduling for farmers using 'can' evaporators. The 'can' evaporators are made from one liter cans with a diameter of 10.5 cm, hung on posts. The bottom of the can was kept at a height of 30 cm above the crop level throughout the growing season. At the beginning of each irrigation, the water level in the can was brought to a reference point, 2.5 cm below the rim. Irrigation scheduling was carried out for wheat and maize grown in a semi-arid region, using cumulative pan evaporation (CPE). Scheduling of 60 mm depth of irrigation when CPE was 60 mm (IW/CPE = 1.00) was found to be optimum for wheat, while 60 mm depth of irrigation when CPE was 50 mm (IW/CPE = 1.20) was found to be optimum for maize. Cumulative evaporation from the cans (CCE), exposed above these crops, was recorded simultaneously. The ratios were higher over maize than over wheat. The CCE during the different stages of crop growth varied from 60.6 to 69.0 mm in wheat and from 51.5 to 94.0 mm in maize. The recommended depth of water in the can is obtained by multiplying the CPE with smoothed average CCE/CPE ratios. These depths may be marked inside the can for easy identification by the farmer. (Moore-IVI) One of the most effective ways of increasing irriga-

IRRIGATION IN THE GREAT PLAINS, Kansas State Univ., Manhattan. Dept. of Agrono-

For primary bibliographic entry see Field 3F. W84-03452

ESTIMATION OF EVAPOTRANSPIRATION AT ONE TIME-OF-DAY USING REMOTELY SENSED SURFACE TEMPERATURES, California Univ., Davis. Dept. of Land, Air and J. L. Hatfield, A. Perrier, and R. D. Jackson.

Agricultural Water Management, Vol. 7, No. 1-3, p 341-350, 1983. 5 Fig, 1 Tab, 20 Ref.

Descriptors: \*Evapotranspiration, \*Remote sensing, \*Surface temperature, Energy, Aerodynamic resistance, Net radiation, Air temperature, Wind.

The estimation of evapotranspiration on a regional scale may be possible using remotely sensed inputs to surface energy balance models. Energy balance considerations lead to a relation that includes net considerations lead to a relation that includes net radiation, surface and air temperatures, and an aerodynamic resistance, as inputs. The resistance term was examined as to its behavior under both stable and unstable temperature conditions, several surface roughness conditions, and at various windspeeds. The model shows that the evapotranspiration is higher than net radiation when the surface is cooler than the air and lower when the surface is cooler than the air and lower when the surface is warmer than the air. The aerodynamic resistance changes due to surface-air temperature differences play a substantial role in determining evapotranplay a substantial role in determining evapotrans-spiration. To test the model, evapotranspiration was calculated using remotely sensed tempera-tures, with the remaining inputs conventionally assessed. The calculations were made for a one-time-of-day period near midday, as would be re-wired for a remote sensing technique, and were quired for a remote sensing technique, and were compared to lysimetrically determined evapotran-spiration. The measured data were obtained at several locations in the Western United States, and were for a variety of crops. The good agreement between calculated and measured values indicates that the goal of developing techniques that produce accurate evapotranspiration estimates over large areas is attainable. (Author's abstract) W84-03453

ESTIMATION OF DAILY EVAPOTRANSPIRA-TION FROM ONE TIME-OF-DAY MEASURE-

R. D. Jackson, J. L. Hatfield, R. J. Reginato, S. B. Idso, and P. J. Pinter, Jr.

Agricultural Water Management, Vol. 7, No. 1-3, p 351-362, 1983. 7 Fig, 1 Tab, 13 Ref.

Descriptors: \*Remote sensing, \*Evapotranspira-tion, Surface temperature, Model studies, Satellite technology.

The estimation of evapotranspiration (ET) on a regional basis requires remote sensing inputs. When obtained from air or space platforms, remotely sensed measurements are usually made at moterly sensed measurements are usually made at periodic intervals, and are essentially instantaneous in nature. A problem, then, is the estimation of daily values of ET from one time of day measurements. A technique is presented that allows the calculation of the coefficient necessary to convert one time of day measurements to daily totals. Input requirements are latitude, day of year, and time of day. This coefficient was applied to measured one time of day ET values and the results were com-pared to lysimetrically determined daily totals obtained at five locations and for four crops. One time of day ET was also calculated using an ET model that requires remotely sensed surface tem-peratures. These values were converted to daily totals and compared with measured values. The results indicated that reliable estimates of daily total ET from one time of day measurements could be made for cloud free days. For cloudy days the results are less reliable, but they suggest that esti-mates may be improved by considering the amount and temporal distribution of cloud cover. (Au-thor's abstract) W84-03454

#### 2E. Streamflow and Runoff

LOW FLOW SYNTHESIS BY COMPUTER; PART ONE,

Shawinigan Engineering Co. Ltd., Montreal (Quebec).

D. Duba, and J. R. G. Pitchen.

International Water Power and Dam Construction, Vol. 35, No. 10, p 52-54, October, 1983. 4 Fig.

#### Group 2E-Streamflow and Runoff

Descriptors: \*Streamflow, \*Computers, \*Model studies, \*Low flow, Design criteria, Construction, Flow, Bolivia, Rivers.

A streamflow synthesis computer model was applied to check the reliability of extremely low flow values, which occurred within a sequence of monthly flows used for firm energy estimates for a Bolivian river basia. The Streamflow Synthesis and Reservoir Regulation (SSARR) model provided a useful tool for this purpose. It was used to determine whether, based on the recorded rainfall data the world would expressive four flows of the state of the recorded rainfall data the world would expressive four flows of the state of the recorded would expressive four flows of the state of the recorded would expressive flows of the state of the recorded would expressive flows of the state of the recorded would expressive flows of the state data, the model would synthesize low flows of the same order of magnitude as those recorded at Talula. In the coarse of the drainage basin model calibration, elements of runoff were determined by a trial and error method aimed at the best fit of two years of recorded flow data. Consequently it was possible to obtain runoff characteristics of the was possible to obtain runoir characteristics of the drainage basin which were previously not defined. The model contributed significantly to the under-standing of the mechanism of runoff generation and of the interaction among the drainage basin hydrological characteristics. The validation run proved satisfactory and helped reassess the critically low flow estimates which had been received arlier. (Baker-IVI)

LOW FLOW SYNTHESIS BY COMPUTER;

PART TWO, D. Duba, and J. R. G. Pitchen. International Water Power and Dam Construction, Vol. 35, No. 11, p 43-47, November, 1983. 12 Fig, 1 Tab, 2 Ref.

Descriptors: \*Streamflow, \*Computers, \*Low flow, Model studies, Rainfall, Snowmelt, Hydro-logic models, Bolivia, Icla Dam, Dams, Talula.

A model is described which can be used to synthe-size stream flow data where the available information is sparse or non-existent. The model, SSARR, is a mathematical hydrologic model of a river basin is a mathematical hydrologic model of a river basin system throughout which streamflow can be synthesized by evaluating snowmelt and rainfall. In the case cited, only the rainfall was applicable. Two of the three basic components of the model were used; a generalized drainage basin model for synthesizing runoff from rainfall, in which the total drainage basin is separated into relatively homogeneous hydrologic units for independent analysis before summing; and a river system model for routing streamflows from upstream to downstream points through channel storage. The predictive validity of the model proved satisfactory, and it contributed greatly to quantification of the runoff generation mechanism and interaction between generation mechanism and interaction between drainage basin hydrologic characteristics. (Baker-W84-02997

EFFECIS OF LATE-GROWING-SEASON IN-UNDATION ON TREE SPECIES IN THE CEN-

TRAL PLAINS, Kansas State Univ., Manhattan. Dept. of Forestry. M. W. Melichar, W. A. Geyer, W. L. Loucks, and

F. J. Deneke.

Journal of Soil and Water Conservation, Vol. 38, No. 2, p 104-106, March-April, 1983. 1 Fig, 8 Ref.

riptors: \*Floods, \*Water stress, \*Trees, Central Plains, United States, Flood control, Cotton-wood, Hackberry, Honeylocust, Mulberry, Black walnut, Reservoirs, Vegetation.

Recreational sites are associated with reservoirs developed for flood control and/or irrigation throughout the United States. Planners in charge throughout the United States. Planners in charge of tree planting programs on floodplains should consider submersion tolerance of the trees. Sixteen species of trees that were completely or partially submerged following late summer flooding in central Kansas were observed. Generally, the species performed as reported in the literature. There were, however, some exceptions. Cottonwood, hackberry, honeylocust, and mulberry, which are normally regarded as tolerant species, had high death and/or stress rates, while black walnut, normally an intolerant species. had only 4% of the mally an intolerant species, had only 4% of the observed trees die following inundation. Complete

inundation increased the number of dead and/or inundation increased the number of dead and/or stressed trees compared with partial inundation. Tree damage was affected not only by the degree of flooding but also by the dormancy state of the trees at the time of inundation. Thus not only the flooding itself, but the season in which it occurred was a significant factor. Species that had hardened before the flood were not affected as dramatically as those species still growing actively. (Baker-IVI) W84-03055

FIELD VERIFICATION OF RUNOFF CURVE

NUMBERS FOR FALLOW ROTATIONS, Kansas State Univ., Manhattan. Dept. of Agricultural Engineering. I M Steichen

Journal of Soil and Water Conservation, Vol. 38, No. 6, p 496-499, November/December, 1983. 5 Fig, 1 Tab, 10 Ref.

Descriptors: \*Runoff, \*Rainfall-runoff relationships, \*Erosion control, Erosion, Model studies, Tillage, Farming, Agriculture, Conservation tillage, Soil conservation.

Conservation tillage practices leave most or all crop residue on the soil surface. This leaves the surface rough. This condition promotes infiltration and reduces runoff. When water infiltrates the soil, it is available for crop use or groundwater reharge. Runoff contributes to surface water supply but, if excessive, causes flooding. A portable rainfall simulator determines Soil Conservation Service runoff curve numbers for fallow rotations at two locations in western Kansas. Field studies supported the estimated curve numbers obtained two locations in western Kansas. Field studies supported the estimated curve numbers obtained by reducing published curve numbers up to 10% for residue cover. Runoff estimates from stubble-mulched areas in northwestern Kansas by reducing curve numbers for residue cover appear reasonable. Although there was some variation due to deep tillage or large cracks, they were relatively short-term conditions that no doubt would change with the rest simplificant rain. Reducing the curve with the next significant rain. Reducing the curve number can reduce significantly the water yield in a semiarid watershed. At Colby, a storm in excess of a 10 year event is needed to yield 12.7 millimeters (0.5 inches) of runoff. (Murphy-IVI) W84-03070

MODEL OF MISSISSIPPI RIVER POOL: MASS TRANSPORT, Rutgers - The State Univ., New Brunswick, NJ. Dept. of Civil and Environmental Engineering.

A. C. Demetracopoulos, and H. G. Stefan.

Journal of Environmental Engineering, Vol. 109,
No. 5, p 1006-1019, October, 1983. 13 Fig, 26 Ref.

Descriptors: \*Computer models, \*Mississippi River pool, \*Mass transport, Hydrodynamics, Water quality, Dissolved solids, flow characteris-

A network of interconnected channels simulates the gravity and wind-driven flow in a river impoundment. A step-function specifies the forcing wind and a quasi-steady state simulation calculates the response for each timestep. A cells-in-series approach with appropriately sized subdivisions to account for dispersion simulates the transport of a conservative dissolved material through the system. The model is formulated and applied to Pool No. 2 of the Mississippi River, and compared with dye tracer data. A review of some field studies showing the importance of weather dependent processes in a shallow river impoundment is also presented. (Murphy-IVI) A network of interconnected channels simulates

THE INFLUENCE OF FLOW TURBULENCE ON FISH BEHAVIOR, Akademiya Nauk SSSR, Moscow. Nauchnyi Sovet

po Neorganischeskoi Khimii For primary bibliographic entry see Field 2H. W84-03106

POTOMAC RIVER STREAMFLOW SINCE 1730 AS RECONSTRUCTED BY TREE RINGS,

Lamont-Doherty Geological Observatory, Palisades, NY.

E. R. Cook, and G. C. Jacoby.

Journal of Climate and Applied Meteorology, Vol. 22, No. 10, p 1659-1672, October, 1983. 9 Fig. 4 Tab, 37 Ref. NSF grants ATM81-08459 and ATM81-16184.

Descriptors: \*Potomac River, \*Stream flow, \*Tree rings, Low flow, Climate data, Climatology, Stream discharge, Meteorological data collection, Drought, Point of Rocks, Maryland.

A 248-year reconstruction of the low-flow (July, August and September) period, of the Potomac River indicates that the prolonged drought of the 1960s may have been the most severe since 1730. There appear to have been several long periods of about 50 years in length when flow was generally above or below the long-term median flow. The period from 1900 through 1950, which comprises most of the measured flow period, was generally above median. Long-period climatic shifts can have important water resource implications. The Potomac River streamflow at Point of Rocks, Maryland was reconstructed by using tree-ring chronologies from sites in or near the river basin. Canonical regression analysis was used to reconstruct simultaneously July, August and September discharge after screening all the tree-ring predictors. Verification statistics and cross-spectral analysis indicate that the average reconstruction of A 248-year reconstruction of the low-flow (July, tors. Verification statistics and cross-spectral analysis indicate that the average reconstruction of these three months is most reliable for periods longer than about six years and shorter than about three years. Spectral analysis of the reconstruction indicates the presence of a 15.7-year periodicity that warrants verification through examination of meteorological data, as well as through additional streamflow reconstructions in the region. The re-construction offers climatologists a greatly length-ened data base from which hypotheses can be formulated and inferences drawn about past behav-ior of the climate system. (Murphy-IVI) W84-03145

RELATIONSHIP OF RUNOFF AND SOIL LOSS TO GROUND COVER OF NATIVE AND RECLAIMED GRAZING LAND,

Science and Education Administration, Mandan, ND. Northern Great Plains Research Center. Agronomy Journal, Vol. 75, p 559-602, July-August, 1983. 4 Tab, 16 Ref.

Descriptors: \*Runoff, \*Soil erosion, \*Ground cover, \*Grazing land, Model studies, Erosion, Infiltration, Land reclamation.

Vegetation cover is a dominant factor in controlling runoff and water erosion from agricultural land and an important criterion for determining adequate reclamation of strip-mined land. A sim lated rainfall study conducted near Center, N.I lated rainfall study conducted near Center, N.D. determines the relationship of ground cover factors to runoff and soil loss. The point frame technique was used to estimate vegetation cover as measured by either the first contact (first hit) of the sliding pins with live vegetation, litter, or bare soil and rock or by a similar contact of the sliding pins at the soil surface (surface hit). Artificial rainfall was applied at the rate of 46 mm/h to 4.0 X 22.1 m runoff plots located on 9 to 12% slopes within reclaimed and unmined pastures. Reclaimed treatments were ungrazed or grazed at light, moderate, or heavy intensity plus vegetation and litter re-moved by burning. Native ungrazed plots had greater live surface cover than ungrazed or lightly grazed reclaimed plots but similar soil loss, runoff, and soil loss/ runoff ratio (SL/RO). Best fit techniques revealed some cover factors linearly related to soil loss, runoff, and SL/RO; others logarithmito soil loss, runori, and SL/RC, others logarithmi-cally related. Live surface cover estimates were poorly related to runoff and soil loss. Adequacy of soil protection can be best estimated by percentage of bare soil. Runoff or soil loss estimates were similar whether total cover was estimated by surface hits or first hits; however, surface hits were easier to determine in tall vegetation under windy conditions. The point frame technique is satisfac-tory for estimating whether the cover is adequate to maintain soil stability on reclaimed land or native range. Its use can be extended to estimate ground cover in other erosion studies. (Murphy-IVI)

# ALLOCHTHONOUS DRIFT FROM BACKWA-TERS TO THE MAIN CHANNEL OF THE MIS-SISSIPPI RIVER,

SISSIPPI RIVEZ.

Luther Coll., P.C., S. Volden, and L. S. Weilgart.

J. W. Eckblad, C. S. Volden, and L. S. Weilgart.

American Midland Naturalist, Vol. 111, No. 1, p. 16-22, January, 1984. 1 Fig. 3 Tab, 17 Ref. NSF grant SPI-8026430, Upper Mississippi River Basin Commission contract 889-305.

Descriptors: \*Rivers, \*Benthic environment, \*Backwaters, Mississippi River, Drift, Allochthonous drift, Ecosystem.

The backwater lakes typically occupy shallow floodplain basins with mean depths less than 1 m, have short mean flushing times, trap both sediments and nutrients carried by influent water, and have relatively high rates of biological productive. heems and indirents carried by indirent water, and have relatively high rates of biological productivity. Blooms of algae and extensive stands of aquatic macrophytes are common in these lentic habitats. A number of sources suggest the importance of these backwaters to the productivity of the large river ecosystem, but studies intended to systematically evaluate the magnitude of backwater inputs to the main channel have not been conducted. Drift in Pool 9 of the Upper Mississippi River was sampled using paried nets suspended at 0.6 m and 2.7 m depths. Diel periodicity in numbers, differences in depth distribution, and differences between sampling months were noted for the drift. Drift coming through large side channels, draining backwater habitats, had mean numbers 10 times larger than that in the main channel of the Missispip River. This allochthonous drift was largely in transport at night and reflected the backwater area stppi River. This allochthonous drift was largely in transport at night and reflected the backwater area drained and, in part, the benthic communities of backwater lakes. The pulsed inputs of allochthonous drift have been largely ignored and may influence the main stem of a large river ecosystem. (Baker-IVI) W84-03323

#### SPATIAL HETEROGENEITY AND MODELS

SPATIAL HETEROGENEITY AND MODELS OF SURFACE RUNOFF, Pittsburgh Univ., PA. Dept. of Civil Engineering. R. C. Quimpo. Journal of Hydrology, Vol. 68, p 19-28, 1984. 32

Descriptors: \*Spatial heterogeneity, \*Model studies, \*Surface runoff, Reviews, Watersheds, Mathematical studies, Mathematical analysis.

Spatial heterogeneity of the processes and parameters which determine surface runoff has given rise eiers which determine surface runoff has given rise to different attempts to improve on the lumped system representation of the watershed. Techniques, ranging from the distributed formulation, component type lumped models and the use of partial source-area and geomorphological concepts are reviewed in order to identify possible areas of future inquiry. The methods tend to focus on different aspects of the problem as influenced by the resources available to the investigators in terms of data and computing capability and accuracy requirements as well as their analytical proclivity. The extensive documented evidence of spatial viginees. data and computing capability and accuracy requirements as well as their analytical proclivity. The extensive documented evidence of spatial variability in most if not all of the parameters in the component models of the runoff process points to the requirement that a realistic model should allow for this heterogeneity. Constrained by the intractibility of a distributed model, it seems that a surrogate approach which tacitly allows for a distribution of parameters would be promising. The choice of an alternate mode must be tempered by the favorable likelihood of data availability to quantify the distribution. (Murohy-IVI) the distribution. (Murphy-IVI) W84-03334

#### THE KERNEL FUNCTION FOR WATERSHED

RUNOFF MODELING, Wuhan Inst. of Hydraulic and Electric Power Engineering (China) C. Shengjia.

Journal of Hydrology, Vol. 68, p 29-37, 1984. 3

Descriptors: \*Kernel function, \*Watersheds, \*Runoff, \*Model studies, Rainfall-runoff relationships, Mathematical models, Unit hydrographs, ships, Mathemat Flood discharge.

Flood discharge.

The relation of the damping effect and lag time is an important law for the kernel function of a watershed. The input steps, the process of flow contribution to a watershed, is the curve of the damping effect for the reservoir regressive flow. The damping effect may be represented in the form of a logarithmic exponent function. Both the storage coefficient and lag time possess the effect of damping. A quantitative formula of the nonlinear kernel function is not only simple but possess general meaning for the analysis of the nonlinear kernel. An improved version of Ding's variable unit hydrograph formula is designed to differentiate between the concepts of the linear and nonlinear reservoir. No matter what the process of the flow contribution for nonlinear or linear is, all are effected by the damping and lag time. (Murphy-IVI) IVI) W84-03335

#### URBAN DESIGN-STORM SENSITIVITY AND RELIABILITY,

Prickett (Thomas A.) and Associates, Urba For primary bibliographic entry see Field 4A. W84-03336

# MATHEMATICAL MODELLING FOR FOR-MATION AND PROPAGATION OF FLOODS IN A DATA-DEFICIENT BASIN,

Bihar Coll. of Engineering, Patna (India). Dept. of Civil Engineeering.
T. Prasad, and O. N. Wakhlu.

Journal of Hydrology, Vol. 68, p 311-329, 1984. 3 Fig, 2 Tab, 8 Ref.

Descriptors: \*Flood control, \*Model studies, Floods, River basins, Runoff, Nash model, Storms, Manning's roughness coefficient, Mathematical

A continuing study on the application of some modern concepts and techniques in hydrologic analysis to practical problems of a river basin is reviewed. Limitations imposed by the type, length, frequency and reliability of data as well as by computational facilities available are reported. computational facilities available are reported. Two inter-related processes investigated are the formation of floods and propagation of a flood flow down a river channel. For the former, the concept of the instantaneous unit hydrograph representing the basin response in transforming rainfall to runoff and the analysis based on the Nash model are applied. For the latter, a modified Muskingum method is proposed. An expression for variation of Manning's roughness coefficient with stage and a mathematical formulation for river rating for all stages of flow including flood flows have been obtained and tested for their validity for a particular section of the Jhelum River. (Bakera particular section of the Jhelum River. (Baker-IVI) W84-03349

#### HYDRAULIC GEOMETRY OF FLOOD-PLAINS.

Illinois State Water Survey Div., Champaign.

N. G. Bhowmik.

Journal of Hydrology, Vol. 68, p 369-401, 1984. 15
Fig, 7 Tab, 20 Ref.

Descriptors: \*Flood plains, \*Hydrology, Geometry, River basins, Streamflow, Runoff, Drainage areas, Illinois.

The shape, the size, the extent, and the spread of present-day floodplains are the end-products of the dynamics of streams and river systems which have been working on the earth's crust from prehistoric been working on the earth's crust from prenistoric times. The hydraulic geometry of floodplains for various river basins was investigated to determine the variability and similarity of the hydraulic geometry relationships for these river basins. Data for 9 river basins in Illinois and 4 river basins

#### Streamflow and Runoff-Group 2E

outside the state were analyzed. The Horton-Strahler stream-ordering system and the concept of hydraulic geometry, which are valid for streams in the humid areas of the United States are also applicable to the floodplains of the rivers. The floodplains are carved in a systematic means. applicable to the floodplains of the rivers. The floodplains are carved in a systematic manner and the development of the floodplain follows a systematic pattern. The floodplain hydraulic geometry parameters of width, depth and cross-sectional area are related to the stream order and they increase in the downstream direction. The other parameters, sinuosity, incision, 100-yr discharge and drainage area are also related to stream order and drainage area are also related to stream order and they increase in magnitude in the downstream direction. The magnitudes of each hydraulic or geometric parameter within each river basin and for each stream order have frequency distributions varying anywhere from skewed to the left, to symmetrical, to skewed to the right. The frequency distribution of the hydraulic parameters for the mountainous stream for each stream order is generally nonskewed. In Illinois, streams in the nongla-ciated or infrequently glaciated areas are more sinuous than those in the glaciated areas. (Baker-

#### W84-03351

CRUE: A MODEL FOR CALCULATION THE PROBABILITY OF RIVER FLOODING (CRUE: UN MODELE D'ESTIMATION DES PROBABI-LITES DES DEBITS DE CRUE).

J. Miquel Houille Blanche, No. 2, p 95-103, 1983. 10 Fig, 11

Descriptors: \*Mathematical models, \*Probabilistic process, \*Flooding, Flood flow, Model studies, Computer models, Computers, Analog computers, characteristic

Many factors are involved with flooding probability models. Using descriptive information (meteorology, human influences, types of floods), flow characteristics and historic records it is possible to develop a functional and applicable model for calculating the probability of river flooding. The model can directly compute a series of observed flows (or depths) for large or small flood basins. The use of this model is facilitated by the availability of a computer program and a practical estimating guide. The control must be stationary and contain homogeneity. (Murphy-IVD) contain homogeneity. (Murphy-IVI) W84-03359

AN ATTEMPT TO PRE-DETERMINE LOW WATER FLOWS IN STREAMS LOSING WATER IN CALCAREOUS REGIONS: EXAMPLE OF THE TILLE RIVER BETWEEN TILL CHATEL AND SPOY (21) (ESSAI DE PREDETERMINATION DES DEBITS D'ETIAGE SUR LES COURS N'EALL DEPENTANT. LES COURS D'EAU PRESENTANT DES PERTES EN REGION CALCAIRE, L'EXEMPLE DE LA TILLE ENTRE TIL-CHATEL ET SPOY

Service Regional de l'Amenagement des Eaux de Bourgogne, Dijon (France). M. Marion.

Houille Blanche, No. 2, p 119-126, 1983. 9 Fig. 5 Tab. 25 Ref.

Descriptors: \*Prediction, \*Low flow, \*Streamflow, \*Calcareous soils, \*Tille River, Streamflow forecasting, Geomorphology, Karst, Karst hydrology, Mathematical studies, Graphical analysis.

While it is possible often to determine approximately the characteristic low level flows of a river at a hydrometric station, the transposition of these values to other points of the basin most often provides rough estimates, in particular because of the exchanges between the stream and sunken terrains. Transposition generally cannot be performed for water crossing karst sections by reason of the losses affecting the stream, which may cause it to dry up over very long periods. To solve this problem the flow is measured simultaneously at the hydrometric stations checking the flow at entry to the karst system, as well as at three points along the karst system, as well as at three points along the zone of losses. The threshold below which the flow entering the system is insufficient to prevent

#### Field 2—WATER CYCLE

#### Group 2E-Streamflow and Runoff

the river from drying up, the characteristic flows at low water and the lengths of time the river remains dry for various return periods are defined for each site. (Murphy-IVI) W84-03362

RUNOFF MODELS IN A SMALL URBAN WA TERSHED: FIRST RESULTS OF AN EXPERI-MENTAL STUDY (MODELE DE CRUE DANS UN PETIT BASSIN URBAIN: PREMIERS RE-SULTATS D'UNE RECHERCHE EXPERIMEN-TALE),

Universita di Reggio Calabria, Cosenza (Italy). Di-partimento di Difesa del Suolo. F. Calomino, C. Colosimo, V. A. Copertino, and

P. Veltri Houille Blanche, No. 2, p 131-140, 1983. 7 Fig. 4 Tab. 26 Ref.

Descriptors: \*Runoff, \*Watershed models, \*Urban watersheds, Flood peak, Rainfall-runoff relation-ships, Runoff forecasting, Hydrographs, Literature

After a brief review of runoff models commonly proposed in the literature, some simple models are proposed in the literature, some simple models are employed (Single linear reservoir model, Nash model, Kinematic model), in order to study the problems concerning peak flows in urban areas in Luzzi, Consenza, Italy. Different types of design rainfall are compared to determine the most effective method. A general indication on the application of these models and on the estimation of model parameters are inconclusive mainly because of insufficient data. (Murphy-IVI) W84-03363

FOCUSING MECHANISMS IN THE TEXAS HILL COUNTRY FLASH FLOODS IN 1978, National Oceanic and Atmospheric Administra-tion, Boulder, CO. Environmental Research Labs. For primary bibliographic entry see Field 2B. W84-03364

DISAGGREGATION PROCEDURES FOR GENERATING SERIALLY CORRELATED FLOW

Cornell Univ., Ithaca, NY. Dept. of Environmen-

Cornell Univ., Infaca, NY. Dept. of Environmental Engineering.

J. R. Stedinger, and R. M. Vogel.

Water Resources Research, Vol. 20, No. 1, p 47-56, January, 1984. 1 Fig., 40 Ref. 1 Append. NSF grant CME-8010889.

4

Descriptors: \*Disaggregation, \*Flow vectors, \*Statistical models, Covariance, Computer models.

Disaggregation models provide a straightforward procedure for dividing annual or seasonal flows among subperiods and dividing aggregate flows among subbasins. The structure of disaggregation models places severe constraints on the feasible values of the lagged covariance of generated flow vectors. A new and simple class of disaggregation models is presented which employ disaggregation models structure but allow the models' innovations to be serially correlated. These models can reproduce: the covariance with the upper level flows; and reasonable approximations to the lag one covariance of the disaggregated flow vectors given the constraints imposed by a disaggregation approach. While the mathematical formulation of disaggregation models is independent of the dimension of Z sub t and X sub t, those values have a tremendous effect on the computer storage space and processing capacity necessary to use such models. To disaggregate simultaneous annual flows at 10 gages to monthly flows wold result in a matrix containing 1200 elements and a covariance matrix with 7260 disinct elements. One can reduce the size of an all at once disaggregation model if one chooses not to recoduce the observed search. Disaggregation models provide a straightforward matrix with 7260 distinct elements. One can reduce the size of an all at once disaggregation model if one chooses not to reproduce the observed sample covariance among every monthly flow observed at every site. More appealing from a modeling and computational point of view is to use a staged disaggregation procedure. The Mejia-Rousselle disaggregation model in general fails to reproduce the anticipated variances and covariances of the disaggregated flows because the model and its

estimators are not self-consistent. (Moore-IVI) W84-03412

RIVER FLOW RECONSTRUCTIONS AND THEIR USE, PART 1, University of East Anglia, Norwich (England). Climatic Research Unit.

Water Services, Vol. 87, No. 1053, November, 1983. 10 Ref.

Descriptors: \*River flow, \*Model studies, River catchments, Catchment areas, River Thames, River flow reconstruction.

In order to demonstrate the accuracy of river flow reconstruction, the Central Water Planning Unit catchment model is fitted to the River Thames to Teddington over the period 1951-76. The estimated river flows for 1885-1976 are then compared with the measured river flows. While the exercise did not demonstrate conclusively that the model reproduces the characteristics of the last one hundred weer flow on the River Themse, the results dred years flow on the River Thames, the results are in broad agreement. A discrepancy in the results are in broad agreement. A discrepancy in the results for low flow of 9 months duration, and also for longer durations, is due to the use of a catchment with a high groundwater contribution to the flow. (Baker-IVI) W84-03423

REGIONAL VARIABILITY OF SOIL CHARAC-TERISTICS FOR FLOOD AND LOW FLOW ES-TIMATION.

New Mexico State Univ., Las Cruces. Dept. of Crop and Soil Sciences.

A. Gustard. Agricultural Water Management, Vol. 6, No. 2/3, p 255-268, 1983. 6 Fig, 2 Tab, 17 Ref.

Descriptors: \*Flood control, \*River flow, Estimating, Soil properties, Europe, Rivers, Spatial distribution, England, Rainfall, Model studies, Drainage, Permeability, Slope.

The applied hydrologist is required to estimate extreme flood and low river flows for the design of flood control and water resource schemes. Many projects are located where river flow data are absent and indirect estimates of flow statistics must be made, either by using a rainfall-runoff model or by using empirical relationships between river flow statistics and the physical and climatic characterisstatistics and the physical and climatic characteristics of catchment areas. The importance of the role of soil and geology in influencing the low flow behavior of rivers is illustrated by referring to the Low Flow Study of the United Kingdom of 1980. A current investigation of floods in European rivers is also examined which requires the development of a map displaying the spatial variability of the hydrological characteristics of the soils of Europe. On the regional, national and international scale it is difficult to use detailed observations of scale it is difficult to use detailed observations of the physical characteristics of soils because of the problems of taking measurements at a large number of sites and over long periods of time. More immediate improvements in flood and low flow estimation will arise from an extension of soil surveying together with feedback at the catchment surveying together with feedback at the catchment scale from an analysis of hydrological data. The wider use of field measurements of soil properties will improve physically based models of catchment behavior and estimates of soil moisture deficits from climate data, thus assisting in developing models appropriate for regional flood and low flow estimation. (Baker-IVI) W84-03440

A NUMERICAL PROCEDURE FOR THREE-DIMENSIONAL TRANSIENT FREE SURFACE

Arizona Univ., Tucson. Dept. of Civil Engineering Arizona Univ., 1 ucson. Dept. of Civil Engineering and Engineering Mechanics.
C. S. Desai, J. G. Lightner and S. Somasundaram. Advances in Water Resources, Vol. 6, No. 3, p. 175-181, September, 1983. 15 Fig, 1 Tab, 14 Ref.

Descriptors: \*Surface flow, \*Finite element method, Seepage, Surface runoff, Runoff, Dams.

Most of the numerical solutions studies based on techniques such as the finite difference, finite element and boundary integral methods have considered two-dimensional plane and axi-symmetric idealizations. Few studies, though, have considered three-dimensional analysis including confined, steady free surface and transient free surface flow. This three-dimensional analysis is based on a time-integration solution of the governing differential equations of flow. The procedure is applied for solution of transient free surface flow including verification with respect to test results from a lab model. It is capable of providing values of fluid heads, velocities and plots of equipotentials in structures such as dams, slopes and wells. (Baker-IVI) IVI) W84-03467

HYDROLOGY OF A BASIN WITH EXTREME RAINFALLS- CROPP RIVER, NEW ZEALAND, Ministry of Works and Development, Christ-church (New Zealand). Water and Soil Div. G. A. Griffiths, and M. J. McSaveney. New Zealand Journal of Science, Vol. 26, No. 3, p 293-306, 1983. 7 Fig. 3 Tab, 37 Ref.

Descriptors: \*Rainfall, \*Hydrology, \*River basins, Rivers, Runoff, Rainfall-runoff relationships, Cropp River, Alps, Mountains, Sedimentation, Floods, Vegetation, Precipitation, Rainfall intensi-ty, Storms, Southern Alps, Erosion.

Cropp River, in the western Southern Alps. is a mountain torrent draining an area subject to frequent heavy rains. More than 100 storms occurred in 850 days of record. The rate of increase of rainfall depth with duration is independent of return period, and with respect to return period independent of duration, for short return periods independent of duration, for short return periods and comparatively short durations. Both rainfall isohyets and point rainfall intensities generally differ substantially from those predicted by national analyses of these parameters. Annual basin rainfalls could have been precisely predicted from annual mean water discharges. A high ratio of runoff to rainfall and a rapid runoff response to short-duration high-intensity rainfalls produce steep flood waves that rapidly translate down channel. More than half the runoff from storm rainfalls leaves the basin within an hour of rainfall ceasins. Specific annual suspended sediment vield rantalis leaves the basin within an hour of rainfall ceasing. Specific annual suspended sediment yield could have been predicted approximately. Bedload is a small proportion of the total yield and it may move down channel in large floods as waves. The extreme precipitation is the dominating influence on the hydrological characteristics of upper Cropp basin and on the development of soils, vegetation, and geomorphology. (Baker-IVI) W84-03482

#### 2F. Groundwater

THERMAL IMPACT OF RESIDENTIAL GROUND-WATER HEAT PUMPS, Missouri Univ.-Rolla. Dept. of Geological Engi-

neering.
D. L. Warner, and U. Algan.
Ground Water, Vol. 22, No. 1, p 6-12, January-February, 1984. 8 Fig. 3 Tab, 7 Ref.

Descriptors: \*Thermodynamics, \*Groundwater, \*Model Studies, \*Groundwater potential, Simulation, Mathematical models, Hydrothermal studies, Thermal properties, Thermal pollution, Heated water, Heat transfer, Aquifers, Water reuse, Water cooling, Well water, Test wells, Pump wells, Heat pumps, Columbus, Ohio, Houston, Texas, Concord, New Hampshire.

Due to rising energy costs, ground-water heat pumps have come to be regarded as viable means of reducing space heating and air conditioning costs. A residential water-source heat pump is simply a device which exchanges heat between a source and a sink. A computer simulation quanti-fies the potential thermal impact of residential water source heat pump usage on groundwater aquifers. Weather data for nine locations throughout the country estimated the energy requirements for heating and air conditioning a typical resi-

#### Groundwater-Group 2F

dence. These energy requirements were translated into the volumetric water demands for a selected heat pump at each location. A representative model aquifer defined and characterized along with the heat pump water requirements and design (difference between inlet and outlet water tempera-ture) identifies the important paramenters that con-tribute to heat transfer and models the movement tribute to heat transfer and models the movement of the thermal front resulting from injection of heat pump discharge water. The major factor that determines the heat pump thermal impact was the net amount of heat injected into, or removed from an aquifer. Other significant factors included well design, heat pump design, and physical properties of the aquifer such as thickness, porosity and dispersivity. In climates where winter heating demand is very nearly equal to summer cooling demands, the injection of heat pump discharge water did not cause any significant modification of the ambient model aquifer temperature. However, in hot or cold climates where air conditioning or heating demand dominates, measurable thermal heating demand dominates, measurable thermal changes occurred in the model aquifer. The maximum temperature change to be expected is fixed by the heat pump which is, at most, 20 degrees F for existing commercial heat pumps. The exception to this would be cases where interference between injection and production wells occurs, leading to recycling of water between them. There was good agreement between model-generated results and the data taken from an operating heat pump installation. (Murphy-IVI) W84-03072

FLUORIDE IN THE GROUND WATER OF NORTHEASTERN OHIO,

NORTHEASTERN OHIO, Akron Univ., OH. Dept. of Geology. R. G. Corbett, and B. M. Manner. Ground Water, Vol. 22, No. 1, p 13-17, January-February, 1984. 5 Fig. 3 Tab, 18 Ref.

Descriptors: \*Fluoride, \*Groundwater, \*Ohio, \*Drinking water, Chemical analysis, Bedrock, Well water.

It is widely recognized that about 1 mg/l of fluo-ride is the optimum content of drinking water for proper dental health. Based upon the annual averproper dental health. Based upon the annual aver-age of maximum daily air temperatures in the Akron area, the recommended control limits for fluoridation are 0.8 and 1.5 mg/l, with an optimum value of 1.1 mg/l. Fluoride contents range from <0.05 to 5.9 mg/l based upon 255 water samples collected from wells in nine counties of northeastconcete from weis in fine counters or normeast-ern Ohio. Only 16 samples had fluoride contents exceeding 1 mg/l, and all are from the southern trio of counties. Furthermore, all samples high in fluoride are from wells close to or penetrating the fluoride are from wells close to or penetrating the contact between the Allegheny and Pottsville Formations. Data from a line of 34 wells for which logs were obtained indicate that high fluoride water occurs in either the lower part of the Allegheny Formation, or more probably, in the upper part of the Pottsville Formation. Ground waters high in fluoride are related to the bedrock geology. Fluoride data, particularly in the area of potentially high yathes, are important to health profession. nigh in fluoride are related to the bedrock geology. Fluoride data, particularly in the area of potentially high values, are important to health professionals in the prescription of fluoride supplements for children. Such prescriptions should be made only after the water has been tested. (Murphy-IVI) WRAJ0073

THE INVESTIGATION OF AQUIFER PARAMETERS USING MULTIPLE PIEZOMETERS, North West Water Authority, Warrington (Eng-

North West Water Muliotity, Wallington Cong-land), Rivers Div. S. Walthall, and J. A. Ingram. Ground Water, Vol.22, No. 1, p 25-30, January-February, 1984. 6 Fig. 1 Tab, 6 Ref.

Descriptors: \*Piezometers, \*Aquifer characteristics, Geohydrology, Boreholes, Pumping tests, Groundwater storage, Geophysics, Confined aquifers, Aquifers.

The measurement of aquifer parameters including permeability, storage and piezometric head in an observation borehole is an important part of the assessment of the aquifer as a resource. In order to investigate the aquifer parameters of a fissured layered sandstone aquifer, it is necessary to con-

struct and test an abstraction borehole using laboratory, double packer, geophysical and pumping test techniques. Good correlation was found between the techniques when the aquifer was represented by a fissured layered aquifer with low persented by a lissured layered aquiter with low per-meability bands separating layers of higher perme-ability. The use of multiple peizometers proved to be the only way of obtaining sensible results for field pumping tests and has given storage coeffi-cients for both the confined and unconfined sec-tions of the aquifer. (Murphy-IVI) W84-03075

CONTAMINATION ANALYSIS - FLOW NETS AND THE MASS TRANSPORT EQUATION, Florida Atlantic Univ., Boca Raton.

Ground Water, Vol. 22, No. 1, p 31-37, January-February, 1984. 2 Fig, 1 Tab.

Descriptors: \*Groundwater movement, \*Flow pat-tern, \*Path of pollutants, \*Mass transport, Lea-chates, Groundwater hydrology, Permeability, Seepage, Groundwater pollution, Mathematical equations

The introduction of newly-implemented regula-The introduction of newly-implemented regulations allows the hydrogeologist to participate in a more detailed way in the planning of waste disposal facilities. The level of hydrogeological input is a function of the nature and size of the project in question, since this, in turn, determines the budget available for investigation. A simple, analytical procedure for quantifying geohydrological data relating to waste site selection, groundwater contamination, and aquifer characteristics is presented.

The analytical methodology outlined employs an tamination, and aquifer characteristics is presented. The analytical methodology outlined employs an extension of flow-net theory to determine seepage velocity and a derivation of the chemical mass transport equation to predict the attenuation of leachate constituents in the groundwater regime. The mathematical expressions derived take into account both transient and steady-state development of the plume, but are based on sufficient simplifying assumptions to facilitate convenient manipulation on a scientific calculator. The solutions obtained, although approximate, compare favorably with more costly computer-generated revorably with more costly computer-generated revorably with more costly computer-generated re-sults. User application relates to the solution of first-order problems and in cases where a more sophisticated analysis is required, provides input for selecting the appropriate technique. (Wheatley-IVI) W84-03076

REMOTE SENSING AND GEOPHYSICAL IN-VESTIGATIONS OF GLACIAL BURIED VAL-LEYS IN NORTHEASTERN KANSAS,

LEYS IN NORTHEASTERN KANSAS, Kansas State Geological Survey, Lawrence. J. E. Denne, H. L. Yarger, P. A. Macfarlane, R. W. Knapp, and M. A. Sophocleous. Ground Water, Vol. 22, No. 1, p 56-65, January-February, 1984. 8 Fig, 17 Ref.

Descriptors: \*Kansas, \*Glacial aquifers, \*Remote sensing, \*Groundwater potential, Geophysics, Groundwater hydrology, Test wells, Seismic properties, Satellite technology.

Aquifers found in glacial buried valleys are a major source of good-quality ground water in northeast-ern Kansas. The extent and character of many of these deposits are not precisely known. Test drill-ing, Landsat imagery, shallow-earth temperature measurements, seismic refraction, surface electrical resistivity, and gravity data were used to evaluate two sites in Nemaha and Jefferson Counties. Tonal patterns on springtime Landsat imagery and winter/summer anomalies in shallow-earth temperatures were quick and inexpensive methods for locating some glacial buried aquifers and suggested areas for more intensive field studies. Reversed areas for more intensive field studies. Reversed seismic refraction and resistivity studies were generally reliable indicators of the presence or absence of glacial buried valleys, with most depth determinations being within 25% of test-drilling results. The effectiveness of expensive test-hole drilling was greatly increased by integrating remote sensing, shallow-earth temperature, seismic, and resistivity techniques in the two buried valley test areas. A gravity profile allowed precise definition

of the extent of one of the channels after the other techniques had been used for general information. (Murphy-IVI)

DETERMINATION OF HORIZONTAL AQUI-FER ANISOTROPY WITH THREE WELLS, Arizona Univ., Tucson. Dept. of Hydrology and

S. P. Neuman, G. R. Walter, H. W. Bentley, J. J.

Ward, and D. D. Gonzaliz. Ground Water, Vol. 22, No. 1, p 66-72, January-February, 1984. 5 Fig. 1 Tab, 8 Ref. 2 Append.

Descriptors: \*Anisotropy, \*Aquifer testing, \*Pumping tests, Confined aquifers, Field tests.

Existing methods for the determination of horizon-tal aquifer anisotropy by means of pumping tests require a minimum of four wells, one for water withdrawal and three for drawdown observations. This paper shows how the same methods can be rins paper smows now the saalie meditions can be used to determine anisotropy with as few as three wells, if at least two of them can be pumped in sequence. A field example is included. A method of analyzing data from more wells than the above minimum, by least squares, is also described. (Author's abstract)

GEOHYDROLOGY AND HYDROCHEMISTRY OF THE DAKOTA AQUIFER, CENTRAL UNITED STATES,

Kansas State Geological Survey, Lawrence. R. B. Leonard, D. C. Signor, D. G. Jorgensen, and O. Helgesen.

Water Resources Bulletin, Vol. 19, No. 6, p 903-911, December, 1983. 10 Fig, 28 Ref.

Descriptors: \*Geohydrology, \*Water chemistry, \*Dakota aquifer, Aquifers, Dissolved Groundwater recharge, High Plains, Brines Dissolved solids.

The Dakota aquifer, composed of the Dakota Sandstone and stratigraphically equivalent sandstone units of Cretaceous age, is the upper-most regional aquifer underlying the extensively developed High Plains aquifer of the midwestern United States. The concentration of dissolved solids in ground water of the Dakota aquifer ranges from less than 500 milligrams/liter in calcium bicarbonate type water in the eastern outcrop area to more than 100,000 milligrams/liter in sodium chloride type oilfield brine in the Denver Basin to the west. Preliminary maps showing the distribution of dissolved solids confir: the complex nature of the Dakota aquifer as inferred from stratigraphic and hydraulic evidence. Extensive vertical leakage hydraulic evidence. Extensive vertical leakage through confining layers, local recharge at the truncated eastern boundary, and a barrier to recharge along the western edge of the Denver Basin are consistent with the distribution of hydraulic head and dissolved solids. (Author's abstract). W84-03394

KRIGED ESTIMATES OF TRANSMISSIVITY IN THE MESILLA BOLSON, NEW MEXICO,

Greenhorne and O'Mara, Inc., Denver, CO. M. R. Palumbo, and R. Khaleel. Water Resources Bulletin, Vol. 19, No. 6, p 929-936, December, 1983. 7 Fig. 2 Tab, 18 Ref.

Descriptors: \*Kriging, \*Transmissivity, \*Mesilla Bolson, \*New Mexico, Santa Fe Aquifer, Mathe-matical studies, Analysis of variance, Aquifer char-

Kriging utilizes a statistically based procedure of spatial interpolation that incorporates the spatial correlation structure of the phenomenon, and provides an error estimate. Kriging was applied to a total of 141 transmissivity values in an attempt quantify the transmissivity distribution of the Santa Fe aquifer in Mesilla Bolson, New Mexico. The salvits required control many of estimated transmissivity many of estimated transmissions. analysis produced contour maps of estimated trans-missivity values and associated estimation varmissivity values and associated and fitting of an exponential variogram to 141 natural log of transmissivity (lnT) values, the range was 3 miles,

#### Field 2-WATER CYCLE

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the average variance 2.74 (theta sub lnT-1.65) with a mean of 8.65. Kriged estimates were generally lower compared to estimates based on available transmissivity maps. (Murphy-IVI)

A SIMPLE ANALYTICAL SOLUTION FOR THE BOUSSINESQ ONE-DIMENSIONAL GROUNDWATER FLOW EQUATION,

Thessaloniki Univ., Salonika (Greece). Lab. of Hydraulics and Hydraulic Works.

P. K. Tolikas, E. G. Sidiropoulos, and C. D. Tzimopoulos.

Water Resources Research, Vol. 20, No. 1, p 24-28, January, 1984. 5 Fig, 1 Tab, 13 Ref.

Descriptors: \*Groundwater movement, \*Mathematical equations, \*Boussinesq equation, Differential equations, Piezometric head, Groundwater re-

Boussinesq's equation describing groundwater flow is a nonlinear parabolic partial differential equation. An approximate analytical method was developed for the solution of the nonlinear one-dimensional Boussinesq equation. Uniform initial conditions and a step function increase of piezometric head on the boundary are assumed. The analysis, based on integral relations, reduces the solution of the differnial equation to a simple system of nonthe differntial equation to a simple system of non-lineart algebraic equations, which can be solved by hand. The analysis makes use of basic characteristics of the solution that are derived directly from the differential equation. The existence of an inflec-tion point is established and the determination of its position clarifies the behavior of the solution. its position clarines the behavior of the solution. The technique can also be applied to one-dimensional nonlinear diffusion problems. The method cannot be applied to the problem of dewatering, due to the fact that an inflection point does not appear in the piezometric head profile and thus the basic causilisation and constitution of the solution. appear in the piezometric nead prome and thus the basic qualitative and quantitative criteria exploited in the construction of the approximate solution are not applicable. For the problem of recharge of an aquifer from a stream, the method provides a very aple algebraic formula for the computation of ored volume and piezometric head profile. (Moore-IVI)

FINITE-ELEMENT METHODS BASED ON A TRANSPORT VELOCITY REPRESENTATION FOR GROUNDWATER MOTION,

Dienst Grondwaterverkenning TNO, Delft (Netherlands). W. Zijl.

Water Resources Research, Vol. 20, No. 1, p 137-145, January, 1984. 6 Fig, 16 Ref.

Descriptors: \*Groundwater movement, \*Velocity, Solute transport, Advection, Computer models, Simulation, Mathematical models, Pollutants, Heat.

Since the primary transport mechanism of pollutants and heat in a subsurface flow system is advec-tion, accurate determination of the velocity of the carrier fluid percolating through the porous medium is extremely important. Computer-based groundwater motion simulators conventionally use pressure as the primary variable, and after the pressure field is calculated, the velocity is determined by numerical differentiation. This paper pre-sents an approach to a direct numerical solution of sents an approach to a direct numerical solution of the transport velocity field. Evidence is provided to show that it is advantageous to base a finite-element-oriented simulator on a transport velocity representation (TVR) of Darcy's law. The com-puter code then requires less storage and fewer arithmetic operations than a pressure representa-tion (PR) version of the same code provided that tion (PR) version of the same code, provided that the same accuracy for the transport velocity is required in both cases. (Author's abstract) required in W84-03420

THE VARIABILITY OF RECHARGE OF THE ENGLISH CHALK AQUIFER,

S. R. Wellings, and J. D. Cooper. Agricultural Water Management, Vol. 6, No. 2/3, p 243-253, 1983. 6 Fig. 9 Ref.

Descriptors: \*Aquifers, \*Recharge, England, Chalk aquifer, Groundwater recharge, Ground-water management, Groundwater pollution, Ni-

The Chalk aquifer is the major water supply aquifer in England. Arable farming is the predominant land use over most of the outcrop area and nitrate pollution associated with this is causing problems. The fissure system provides a potential fast route for pollutants to reach the water table. The hydrotor pollutants to reach the water table. The hydrological behavior of the upper 3 m of the Chalk profiles appear to depend on two properties: the thickness of soil cover or the depth of disturbance of the Chalk, which controls the water storage characteristics at high matric potentials; and the saturated matric conductivity of the Chalk, which determines the frequency with which the fissure system becomes water-filled. (Baker-IVI) W84-03439

SEEPAGE FROM LAKE BURULLUS INTO THE RECLAIMED MANSOUR AND ZAWIA POLDER AREA, Euroconsult, Arnhem (Netherlands). J. H. Boumans, and A. M. Mashali. Agricultural Water Management, Vol. 7, p 411-424, 1983. 4 Fig, 5 Tab, 5 Ref.

Descriptors: \*Groundwater movement, \*Seepage, \*Mansour, \*Zawia, \*Egypt, \*Land reclamation, \*Saline water, Lake Burullus, Polders, Drainage effects. Water table. Saline soils

In 1960, a part of Lake Burullus, situated west of the north-central part of the Nile Delta, along the Mediterranean, was diked in, which created the Zawia and Mansour polder area of 27,300 ha. Reclamation was not fully successful, however, and the agricultural land is still highly saline. The groundwater tables are still too high and the drainage should be intensified and deepened. The thickness, nature and permeability of the clay cap overlying the extended sand and gravel aquifer are such that there is little risk that seepage will increase greatly after lowering the waterstables in the greatly after lowering the water-tables in the polder area. Piezometer studies indicated that seepage rates under the present conditions are very age rates under the present condutions are very limited, which implies that an increase after im-proved drainage would remain very restricted. These findings were confirmed by calculations of the seepage flow for present and future conditions. The calculated seepage increase and the total future seepage inflow reaching the polder are minor and practically neglible compared with the available drainage capacity. Rates five to ten times higher than those calculated could easily be handeled by the existing drainage system. (Moore-IVI) W84-03456

DELAYED YIELD, AN EXACT QUASI-THREE DIMENSIONAL MODEL FOR FREE-AOUIFERS.

AQUIFERS, Universidad Nacional Autonoma de Mexico, Mexico City. Inst. de Investigacion en Matematicas Aplicadas y en Sistemas. I. Herrera, and B. Chen.

Advances in Water Research, Vol. 6, No. 1, p 54-58, March, 1983. 2 Fig. 17 Ref.

Descriptors: \*Aquifers, \*Model studies, Mathematical equations, Boulton's theory, Surface flow, Waves, Delayed yield, Leaky aquifers.

ional model of free surface flows is developed for free aquifers and waves. The zero-order approximation of this model yields Boulton's theory of delayed yield, elucidating in this manner the nature of the latter theory. The study demonstrated the linearized theory of free-aquifers to be exactly equivalent to an integrodif-ferential equation in which the partial derivatives involved are taken in the horizontal directions only and time. When a contine transform is used in the involved are taken in the horizontal directions only and time. When a cosine transform is used in the vertical direction a system of equations is obtained.

If N terms are taken in the cosine representation an exact theory is obtained, except for the fact that the kernel w is approximated by the kernel w sub N. The zero-order approximation yields Boulton's delayed yield equation. The approximated kernel w sub N converges rapidly to the exact kernel w. This implies that if only one term is taken, a theory in which w has been replaced by w sub 1 is obtained, but it is otherwise exact. Such approximation seems to be quite adequate for most practi-cal applications. (Baker-IVI)

OPTIMUM MANAGEMENT OF A REGIONAL CONFINED AQUIFER,
Thessaloniki Univ., Salonika (Greece).
D. Tolikas, P. Latinopoulos, P. Tolikas, and J.

Advances in Water Resources, Vol. 6, No. 2, p 66-70, June, 1983. 8 Fig, 5 Ref.

Descriptors: \*Confined aquifers, \*Groundwater management, Management, Ptolemais, Greece, Mathematical models, Model studies, Optimization, Sensitivity analysis.

A management study was conducted for an aqui-fer-well system located in the industrial area of Ptolemais, Greece. An analytical solution for the steady state problem is obtained and parametric calibration of the mathematical model simulating the aquifer-well system follows. Calculated numerical results are compared with existing field data. An optimization model is introduced and the maximum possible discharge of the aquifer under con-An opumization model is introduced and the maximum possible discharge of the aquifer under continuously increasing pumping rates is calculated. A sensitivity analysis for the maximum discharge conditions follows and the basic assumptions of the conditions follows and the basic assumptions of the mathematical model are checked. Furthermore an analytical relationship is obtained which describes qualitatively the development of the aquifer under pumping rate conditions. In general terms, due to the high value of the transmissivity as well as the limited hydraulic continuity with the neighboring. aquifers the slopes of the hydraulic head are small, while a small increase of the pumping rate creates a considerable lowering of the hydraulic head. a considerative rowering of the hydraulic nead. Therefore the maximum pumping rate from the aquifer is rather small and severe problems will appear in the near future in the industries of the region. (Baker-IVI) W84-03461

ON THE APPLICATION OF THE BOUNDARY LAYER APPROXIMATION FOR THE SIMULATION OF DENSITY STRATIFIED FLOWS IN AQUIFERS,

Florida Univ., Gainesville. Dept. of Civil Engi-

Advances in Water Resources, Vol. 6, No. 2, p 96-105, June, 1983. 5 Fig, 24 Ref.

Descriptors: \*Density stratification, \*Groundwater movement, \*Boundary layers, \*Simulation, Solute transport, Mathematical models, Computers.

Stratification of the density in groundwater flow Stratification of the density in groundwater flow stems from the contact between water which con-tains minerals in low concentration with water containing a high concentration of minerals. The flow in such a flow field should be simulated by solving simultaneously the equations of continuity, solving simultaneously the equations of continuity, motion and solute transport, because solute concentration affects the dynamics of the flow. Such an approach is generally associated with complicated calculations and numerical schemes subject to problems of convergence and stability, as the basic equations are highly nonlinear. This study applies the phenomenological boundary layer approximation, and suggests a reference to three different zones in the flow field: (a) fresh water zone, (b) transition zone, and (c) mineralized water zone. (b) transition zone, and (c) mineralized water zone. In zones (a) and (c) it is assumed that the potential flow theory can be applied. In zone (b) the flow is nonpotential but the basic similarity conditions typical to boundary layers exist. The approach suggested in this study simplifies the mathematical models that should be used for the flow field simulation. This approach is especially attractive in cases where the Dupuit approxmation is applicable. In such cases very often analytical solutions can be obtained for unidirectional flows. In cases that are too complicated for representation by analytical solutions, the method can be used for the creation of simplified numerical schemes. Various

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examples in this study demonstrate the application of the method for various field problems associated with steady state as well as unsteady state conditions. The simplicity of the method makes it useful for variety of problems. It can be used even by small institutions and small consulting firms, who have usually access to minicomputers and microprocessors. (Author's abstract) W84-03463

THERMOHALINE CONVECTION IN FLOW-

ING GROUNDWATER, Technion - Israel Inst. of Tech., Haifa. Faculty of

Civil Engineering.
H. Rubin, and C. Roth.
Advances in Water Resources, Vol. 6, p 146-156,
September, 1983. 10 Fig, 6 Ref.

Descriptors: \*Geothermal studies, \*Groundwater movement, \*Convection, \*Salinity, Water temper-ature, Hydrodynamics, Dispersion, Aquifers, Hy-draulic gradient.

Geothermal activity creates destabilizing tempera-ture gradients which are significant in some aquifers. Usually, in such aquifers stabilizing salini-ty gradients also exist. The combination of temperature and salinity distribution in the aquifer may induce various types of hydrodynamic instabilities. The present article concerns the effect of anisotropic characteristics of the hydrodynamic dispertuopic characteristics of the hydrodynamic dispersion on the growth of instabilities in the aquifer. Three different mechanisms may lead to instability of the flow field: (a) buoyancy forces may induce convection currents; if the difference between the convection currents; if the difference between the convection velocity of salt, due to the hydraulic gradients, and that of heat is negligible, then this mechanism is generally most effective in planes parallel to the hydraulic velocity of the fluid (velocity due to the hydraulic gradient); (b) the difference between heat and salt effective diffusivities may lead to overstability; this mechanism is most effective in planes perpendicular to the hydraulic velocity; (c) the difference between the convection velocity of salt and that of heat may induce oscilla-tions which are most effective in planes parallel to the hydraulic velocity. The growth of instabilities in an aquifer of unlimited length is different from their growth in an aquifer of limited length. In the latter thermohaline convection develops in planes latter thermohaline convection develops in planes perpendicular to the hydraulic velocity, whereas in the former it develops in planes forming an angle theta with the hydraulic gradient. The development of convection cells in the flow field is identified by numerical experiments. These experiments identify the convection cell length and the angle formed between the thermohaline convection plane and the hydraulic gradient. (Author's abstract) stract) W84-03465

### CONVECTION IN AN AQUIFER ABOVE A LAYER OF HEATED IMPERMEABLE BED-

Auckland Univ. (New Zealand). Dept. of Theoretical and Applied Mechanics.

R. McKibbin.

New Zealand Journal of Science, Vol. 26, No. 1, p

49-64, 1983. 11 Fig, 2 Tab, 4 Ref.

Descriptors: \*Geothermal studies, \*Convection, \*Geothermal aquifers, Heat flux, Boundary conditions, Bedrock, Temperature, Rayleigh number.

It has been proposed (Donaldson 1962 Journal of Geophysical Research 67:3449-3459) that a convective geothermal aquifer might overlie a layer of impermeable bedrock which conducts heat from the magmatic source below. Using perturbation conducts similar to that applied to general materialthe magmatic source below. Using perturbation analysis similar to that applied to general materially layered porous media by McKibbin & O'Sullivan (1980, 1981 Journal of Fluid Mechanics 96:375-393; 111:141-173), it is found that the presence of such a layer of bedrock markedly affects the convection patterns and heat flow compared with those which occur when the heat source is in direct contact with the convective system. Results show that the overall temperature difference beshow that the overall temperature difference be-tween the heat source and the top surface required for instability is greater, while the heat flux is reduced for both impermeable and constant pres-

sure upper boundary conditions. However the critical local (aquifer) Rayleigh number is decreased by the presence of the impermeable layer below. All effects are greater for the constant pressure top than for the impermeable top case. (Author's absence) stract) W84-03480

#### 2G. Water In Soils

#### WATER CONDITIONS IN CENTRAL CAUCA-SIAN SUBALPINE MEADOW,

Akademiya Nauk Gruzinskoi SSR, Tiflis. Inst.

C. Sh. Nakhutsrishvili, and Ch. Koerner Doklady Biological Sciences Vol. 267, No. 1-6, p 547-549, November-December, 1982. 3 Ref. Translated from Doklady Akademii Nauk SSSR, Vol. 267, No. 1, p 243-245, November, 1982.

Descriptors: \*Meadows, \*Water supply, Subalpine regions, Mountains, Central Caucasus Mountains, Soil water, Soil-water-plant relationships, Seasonal

Studies were conducted in the region of Kazbegi to examine a Bromus variegatus-Agrostis planifo-lia-Trifolium ambiguum subalpine plant with spe-cial reference to water exhange of the soil, individual plants, and also the phytocenose as a whole. A high leaf water content, a negligible saturation deficit, and a high leaf water potential were noted throughout the growing season. In midsummer and during sunny weather and a 5-6 m/sec wind velocity, the transpiration of the studied plants was always higher in a pasture setting than in an un-grazed meadow setting. A tendency for a reduc-tion in stomatal transpiration in the course of the day also was more strongly expressed in the hay meadow than in the pasture. The elevated water meation than in the pasture may be due to the lower diffusional and aerodynamic resistances of forb leaves and, also, the lower mean diffusional resistance of the phytocenose as a whole, conditioned by the sharp decline in grasses, which are predisposed to an elevated resistance. Grazing leads to a decline in the diversity of strategies in the phytocenose. (Baker-IVI) W84-03025

## QUANTITATIVE EXPRESSION OF SOIL-MOISTURE FUNCTION FOR REMOTE INDI-

Akademiya Nauk SSSR, Moscow. Nauchnyi Sovet po Neorganischeskoi Khimii. B. V. Vinogradov.

Doklady Biological Sciences, Vol. 268, No. 1-6, p 16-18, January-February, 1983. 1 Fig. 4 Ref. Trans-lated from Doklady Akademii Nauk SSR, Vol. 268, No. 4, p 1011-1013, February, 1983.

Descriptors: \*Soil water, \*Mathematical equations, \*Remote sensing, Optical properties, Soil properties, Spectral intensity.

The quantitative expression of the relationship be-tween remote optical characteristics and paramterm remote optical characteristics and paramieters of the natural environment is a major problem in the development of the fundamental bases of a space physical geography. Particularly difficult has been the mathematical description of the relationship between the coefficient of spectral intensity and soil moisture. Experimental investigations on loamy achromatic soils demonstrated the complex nonlinear characteristics of the relationship between the coefficient of spectral intensity (p) in the visible region of the spectrum and the moisture (w) of the 0-2 cm surface soil horizon. An equation is formulated which is the first to yield a quantita-tive expression of the p(w) function throughout the range of soil moisture and to reflect the phase composition of moisture in the soil. This permits broad extrapolation of remote soil-moisture indica-tors, minimization of preliminary sampling, and broad extrapolation of remote sour-mousture indica-tors, minimization of preliminary sampling, and more rapid construction of p(w) calibration curves for changing natural and technical survey condi-tions. (Baker-IVI) W84-03028

TRACING SUBSURFACE FLOW ON ROAD-CUTS ON STEEP, FORESTED SLOPES,

Intermountain Forest and Range Experiment Sta-

Intermountain Forest and Range Experiment Sta-tion, Ogden, UT. W. F. Megahan, and J. L. Clayton. Soil Science Society of America Journal, Vol. 47, No. 6, p 1063-1067, November-December, 1983. 3 Fig, 2 Tab, 23 Ref.

Descriptors: \*Storm seepage, \*Permeability coefficient, \*Roadcuts, Idaho, Sodium, Chlorides, Tracers, Saturated flow, Snowmelt, Macropores, Darcy flow.

In situ hydraulic conductivity was determined in a forested soil in the Idaho batholith by a tracer technique, and values were compared to hydraulic conductivity determined in the laboratory on cored samples. NaCl solutions were injected into cored samples. NaCl solutions were injected into piezometers placed in soil above a roadcut, and time for Na(+)or Cl(-) to appear in outlow at the roadcut during saturated subsurface flow generated from spring anowmelt was determined. Hydraulic conductivity values determined with the NaCl tracer averaged an order of magnitude greater than laboratory derived values. This is likely due to rapid flow in macropores formed from root channels or other biological activity that cannot be sampled by conventional coring and laboratory conductivity tests. Although the field tests indicated flow was clearly non homogeneous and anisotropic, an evaluation of the Reynold's number for the test conditions indicated Darcy flow was octhe test conditions indicated Darcy flow was oc-curring. Sodium analysis provided a more distinct peak than Cl(-) when both concentrations were plotted vs. time. (Author's abstract) W84-03177

#### TRANSIENT METHOD FOR MEASURING SOIL WATER DIFFUSIVITY AND UNSATURATED HYDRAULIC CONDUCTIVITY,

Massey Univ., Palmerston North (New Zealand). Dept. of Soil Science.

D. R. Scotter, and B. E. Clothier. Soil Science Society of America Journal, Vol. 47, No. 6, p 1068-1072, November/December, 1983. 8 Fig. 13 Ref.

Descriptors: \*Permeability coefficient, \*Soil water, \*Diffusivity, Matric potential transient, Soil wetting, Sorption, Desorption, Outflow.

The method for measuring the unsaturated diffusi-The method to reasuring the unsaturated diffusivity of soil involves measurement of the matric potential transient at one end of a soil sample following a step change in the potential at the other end. Small potential steps can be used in contrast with the analogous outflow methods, because the difficult task of accurately measuring small flow rates is obviated. The analysis used to be the six of security described the section of the contract of the security of the section of the s obtain the diffusivity from the potential data relies mainly on the delay in the transient and does not mainly on the delay in the transient and does not depend critically on its shape, thus avoiding the other major problem associated with outflow methods. With the use of the graphs provided, data analysis is simple. Measurement of the total outflow induced by each potential step allows the hydraulic conductivity to be calculated from the diffusivity. Except during primary wetting, the method provides hydraulic conductivity - water content data for repacked sand that showed no hysteresis and agreed with data obtained using a steady-state method. The anomalous behavior observed during primary wetting was perhaps due to steady-state method. The anomalous behavior observed during primary wetting was perhaps due to entrapped air making the retentivity relationship time dependent. When applied to field cores obtained from both relatively permeable and impermeable soil horizons, the method gave consistent hydraulic conductivity data for sorption and desorption and for replicate cores. (Moore-IVI) W84-03178

#### STATISTICAL AND STOCHASTIC ANALYSES OF HYDRAULIC CONDUCTIVITY AND PAR-TICLE-SIZE IN A FLUVIAL SAND,

New Mexico Inst. of Mining and Technology, Socorro. Dept. of Geoscience. E. Byers, and D. B. Stephens. Soil Science Society of America Journal, Vol. 47, No. 6, p 1072-1081, November/December, 1983.

#### Field 2-WATER CYCLE

#### Group 2G-Water In Soils

10 Fig. 6 Tab, 23 Ref. OWRT project B-073-NMEX.

Descriptors: \*Permeability coefficient, \*Particle size, \*Fluvial sands, Statistical analysis, Stochastic process, Soil water, Socorro, New Mexico.

An untilled medium-grained fluvial sand near So-corro, New Mexico, was sampled in horizontal and vertical transects to study the statistical and sto-chastic properties of particle-size parameters and saturated hydraulic conductivity. Hydraulic con-ductivity is log-normally distributed, whereas the 10% finer, median, and geometric mean particle sizes are normally distributed. The strongest corre-lation between hydraulic conductivity and parti-cle-aize distribution parameters is that of the log of hydraulic conductivity with the 10% finer particle size. Stochastic analyses using the autocorrelation size. Stochastic analyses using the autocorrelation function and spectrum indicate that the log of function and spectrum indicate that the log of hydraulic conductivity and particle size are characterized by dissimilar spatial correlation structures in the verticle directions. In general, particle size is more structured, regular, and predictable and shows a close similarity with the stratigraphy as observed in the field. On the other hand, hydraulic conductivity in the vertical direction may best be modeled as a simple random variable. Variogram and kriging analyses indicate that both hydraulic conductivity and particle size are relatively isotropic in the horizontal plane and that marked similarities in spatial structure exist in this plane. The spatial distribution of saturated hydraulic conductivity in the horizontal plane is estimated reasonably well using the empirical relationship reasonably well using the empirical relationship between particle size and conductivity along with the kriged estimates of the 10% finer particle size. (Author's abstract) W84-03179

EFFECT OF SOLUBLE SPECIES RELEASED FROM SOIL SOURCES ON THE COMPOSITION OF SOIL AND DRAINAGE SOLUTIONS, Agricultural Research Organization, Bet-Dagan (Israel).

For primary bibliographic entry see Field 5B. W84-03180

COLOR PATTERNS AND WATER TABLE LEVELS IN SOME INDIANA SOILS,

Purdue Univ., Lafayette, IN. D. P. Franzmeier, J. E. Yahner, G. C. Steinhardt,

and H. R. Sinclair, Jr.
Soil Science Society of America Journal, Vol. 47,
No. 6, p 1196-1202, November/December, 1983. 3
Fig. 1 Tab, 20 Ref.

Descriptors: \*Water table, \*Soil types, \*Indiana, \*Soil color, Soil properties, Seasonal variation, Soil horizons, Soil saturation.

Since many uses of soil depend greatly on its moisture status, it is important to be able to predict the seasonal moisture pattern from soil morphology. The relationship of color patterns in the soil profile to the duration of saturation at various depths was investigated in some soils that are extensive in Indiana. In soils of sandy, coarse loamy, fine loamy, fine silty, and fine particle-size families. fine loamy, fine silty, and fine particle-size families, some general relationship was observed between water table depths and soil color patterns. Horiwater table depins and soil color patterns. Horizons that have dominantly gray (chroma < or = 2) color in the matrix or argillans are saturated much of the year. Horizons that have gray mottles, but are dominantly brown, are saturated a temmonths of the year if they are above the dominantly gray horizons, or are saturated most of the time if these horizons are below the dominantly gray horizon. Horizons that have dominant chroma of three in the matrix, mottles, or argillans are often saturated. Those that have dominant chroma of five or six and have no mottles with chroma of three or less are seldom or never saturated. Soils with three-chroma matrix, mottles or argillans are with unee-chroma matrix, montes of arginans are much wetter than they had been thought to be. These generalizations apply to many soils, but there are exceptions. Some soil colors may be inherited from the parent material and do not reflect soil wetness. (Moore-IVI) W84-03181

EFFECT OF SOIL TEXTURE ON CRITICAL BULK DENSITIES FOR ROOT GROWTH, Agricultural Research Service, Temple, TX. Grassland, Soil and Water Research Lab.

Grassiand, Soil and water Research Lab. C. A. Jones. Soil Science Society of America Journal, Vol. 47, No. 6, p 1208-1211, November/December, 1983. 6 Fig. 1 Tab, 12 Ref.

Descriptors: \*Soil water, \*Soil density, \*Roots, Growth, Clay, Silt, Fragipans, Soil texture.

Published and unpublished data from 10 studies were analyzed to determine the effects of soil texture on critical bulk densities for rooting at near-optimum soil water contents. Highly significant negative relationships were found between percentage clay or silt + clay and the bulk density percentage clay or silt + clay and the bulk density at which rooting was at a maximum or the bulk density at which rooting was at a maximum or the bulk density at which rooting was 0.2 of that maximum. Similar relationships were also found between percentage clay or silt + clay and (i) the bulk densities of soil layers classified as fragipans and (ii) the maximum bulk densities at which 'many' roots are reported in U.S. Soil Conservation Service pedon descriptions. Thus, soil texture can be used to estimate bulk densities of fragipans and critical bulk densities at which root growth is severely affected at near-optimal soil water contents. (Author's abstract)

IRRIGATION DECISIONS SIMPLIFIED WITH ELECTRONICS AND SOIL WATER SENSORS, Agricultural Research Service, Kimberly, ID. Snake River Conservation Research Center. J. W. Cary, and H. D. Fisher.

Soil Science Society of America Journal, Vol. 47, No. 6, p 1219-1223, November/December, 1983. 6 Fig, 2 Tab, 5 Ref.

Descriptors: \*Soil water, \*Irrigation, \*Wetting front, Drying rate, Water management, Micro-

Two simple, inexpensive systems use electrical re-Two simple, inexpensive systems use electrical resistance measurements to provide useful, immediate information to assist decisions made on irrigation water application. In one system a microprocessor-based circuit coupled to a programmable calculator provides an on-site estimate of the time until the next irrigation will be required, based on field data and an operator-supplied parameter. The second system simply signals the arrival of the wetting front at any location in the soil by giving a visual indication, such as raising a mechanical flag. The microprocessor-based circuit measures and visual indication, such as rasing a mechanical mag. The microprocessor-based circuit measures and stores the resistance of four gypsum blocks once a day. The program in the portable calculator access this information and uses it to extrapolate the soil drying rate to predict the number of days until the drying rate to predict the number of days until the next irrigation. By restricting the microprocessor circuit to data acquisition only and putting all number-handling routines into the calculator program, the cost and complexity of the microprocessor circuit is minimized, whereas maximizing the programming flexibility. This makes it feasible to install a number of these devices at different locaitions, all serviced by the same portable calculator. The water infiltration circuit intermittently scans eight sets of stainless steel electrodes to locate the soil wetting from during irrigation. When the resoil wetting front during irrigation. When the re-sistance across the electrodes decreases, signaling the arrival of the front, the circuit trips a spring-loaded flag. This provides a visible sign that the wetting front has reached that point in the soil. The equipment worked well. When irrigation was required in six or fewer days, the microprocessor/ calculator system made correct predictions 85% of the time. An example of how easily any irrigation scheduling method may be converted to the microprocessor/calculator system is presented. (Author's abstract) W84-03183

AN EVALUATION OF THE SUCCESS OF MORECS, A METEOROLOGICAL MODEL, IN ESTIMATING SOIL MOISTURE DEFICITS, ESTIMATING SOIL MOISTORE DEPICTIS. Institute of Hydrology, Wallingford (England) C. M. K. Gardner, and M. Field. Agricultural Meteorology, Vol. 29, No. 4, p 284, 1983. 6 Fig. 5 Tab, 23 Ref.

Vol. 29, No. 4, p 269-

Descriptors: \*Soil moisture, \*Estimating, MORECS, Rainfall, Evaporation, Evapotranspiration, Great Britain, Model studies, Water loss,

MORECS (Meteorological Office rainfall and evaporation aclaulation system) in its operational form uses daily meteorological data to produce weekly estimates of evapotranspiration, soil moisture deficit (SMD) and hydrologically effective rainfall for each square of a 40 x 40 km grid superimposed upon Great Britain. Grid square estimates of meteorological data are found using interpolation methods. A modified version of the Penman-Monteith equation is used to calculate evapotranspiration; a two-reservoir model is used to simulate the extraction of water in the SMD calculations. While the MORECS produces better SMD estimates for grass than earlier versions of the system, there is still a definite bias towards SMD overestimation in most years and underestimation in drought years. Better SMD estimations will arise only when good representative meteorological data is used. For the purpose of the hydrologist spatial detail is not normally needed and interest will be in the overall biases in MORECS SMD predictions explained here. However, for the agriculturalist who needs good SMD estimates for individual fields, errors of this type may be critical. (Baker-IVI) W84-03212

SOIL WATER FLUX IN HUMID TROPICAL LATOSOLS UNDER COCONUT (COCOS NUCI-FERA LINN.),

Center for Water Resources Development and Management, Calicut (India). K. M. Varadan, and B. Raghunath. Agricultural Meteorology, Vol. 30, No. 2, p 99-110, 1983. 4 Fig, 5 Tab, 7 Ref.

Descriptors: \*Soil water, \*Tropical regions, Coconuts, Humidity, Climates, Water supply, Kerala.

In the management of available water resources the necessity for estimation of seasonal variation in the necessity for estimation of seasonal variation in soil moisture storage will go a long way in proper planning for irrigation. For successful plant growth, the water supply should meet demand. The problem is that the evaporative demand of the atmosphere is continuous whereas the supply of atmosphere is continuous whereas the supply of water by natural precipitation is only occasional and irregular. Soil moisture storage depends on the soil water diffusivity, the cumulative infiltration and the distance that water penetrates the soil. Field observations were compared with those computed from meteorological variables. The field observations of soil moisture flux agree closely with computed values for wet periods of the year, while they differ significantly for dry periods. Modification was attempted for the climatic computation by taking into account a lower moisture depletion rate for the dry period. Soil moisture indices have been calculated for the study period as a basis for irrigation management. The observed soil moisture varies from 17.0 to 25.0 cm and 6.8 to 12.8 cm per 75 cm depth of soil profile for wet and dry periods, respectively. (Baker-IVI) W84-03216

RELATIONSHIP OF IRRIGATION WATER SA-LINITY AND SOIL WATER SALINITY, T. L. Prichard, J. L. Meyer, G. J. Hoffman, F. R.

Kegel, and R. Roberts.
California Agriculture, Vol. 37, No. 7 and 8, July-August, 1983. 3 Fig.

Descriptors: \*Soil water, \*Salinity, Leaching, Irrigation water, Deltas, Conductivity, Water table, Irrigation effects.

Irrigation water quality has a dominant influence on soil salinity, but winter rainfall, soil properties, leaching practices, irrigation techniques, and the elevation and salt concentration of a water table elevation and sait concentration or a water usue can significantly affect the relationship. The rela-tion between the electrical conductivity of the irrigation water and the average electrical conduc-tivity of soil water in the root zone for a subirrigat-ed portion of the experimental field is given.

#### Water In Soils-Group 2G

Above average rainfall and maintaining the water table about I meter below the surface effectively leached the upper soil profile. Under present conditions of low salinity in the irrigation water and with normal winter rainfall, soil salinity is about 8 times greater than the salinity of the irrigation water. As the salinity of the irrigation water in-creases, however, the factor 8 becomes substantialsmaller. (Baker-IVI)

WATER RETENTION EQUATIONS AND THEIR RELATIONSHIP TO SOIL ORGANIC MATTER AND PARTICLE SIZE DISTRIBU-TION FOR DISTURBED SAMPLES,

Department of Agriculture, Ottawa (Ontario).

Land Resource Research Inst.
R. de Jong, C. A. Campbell, and W. Nicholaichuk
Canadian Journal of Soil Science, Vol. 63, No. 2,
p. 291-302, May, 1983. 4 Fig, 8 Tab, 20 Ref.

Descriptors: \*Soil properties, \*Organic matter, Water retention, Soil texture, Mathematical equations, Saskatchewan, Soil water

Soil water retention curves are needed by many researchers in order to describe the availability of soil water to plants and to model the movement of water and salts in unsaturated soils. Functional relationships between soil water content and water suction were examined and related to textural and organic carbon content data. Soil water retention organic carbon content data. Soil water retention curves between 5 and 10,000 kPa were determined on disturbed samples of 18 soils representing various soil Great Groups in the Canadian prairies. The empirical two-straight-line model was the most suitable to relate soil water content to water most suitable to relate son water content to water soutcion. A very precise set of equations was developed for the samples chosen. Soil texture appeared to be the main soil property influencing the water retention curves of disturbed mineral soils. Organic matter increased the water content at which a break in the retention curve occurs, but had little effect on the rate of release of water or the soil suction at which the water became more difficultly desorbed. Water retention parameters calculated from particle size distribution and oganic carbon content data allow for general approximations of the relationship between soil water content and water suction. (Baker-IVI) W84-03226

INTERMITTENT INFILTRATION AND EVAP-ORATION FROM SOIL COLUMNS, Saskatchewan Univ., Saskatoon. Dept. of Soil Sci-

M. A. Mustafa, R. De Jong, H. N. Hayhoe, and G.

C. Topp. Canadian Journal of Soil Science, Vol. 63, No. 2, p 303-314, May, 1983. 6 Fig, 3 Tab, 24 Ref.

Descriptors: \*Soil water, \*Infiltration, \*Evapora-tion, Soil columns, Model studies, Richards' equa-tion, Mathematical equations, Soil texture.

Large tracts of land in the arid and semi-arid Large tracts of land in the and and semi-arid regions of Sudan consist of salt-affected heavy clay montmorillonitic soils. Conventional reclamation procedures, including leaching and subsequent drainage, are not feasible because of the low hydraulic conductivity of these soils. Varying total amounts of water (160 and 320 mm) were infiltrated into 60-cm columns of air-dry saline sodic clay soil. The intervals between irrigation applications were varied from 5 to 20 days. The soil columns were valued from 3 to 20 days. The soft commission were subjected to a potential evaporation rate of 4.8 mm/day in a growth room. The cumulative evaporation followed a square root of time response, similar to that found by others for non-saline soils of coarser texture. The percentage of water lost by evaporation was less for the high application rate treatments as compared to the low application rate ones. Provided that more than 40 mm water were added, modelled estimates of evaporation were acceptable when predicted by the analytical solution of the Richards' equation. The versatile soil moisture budget model gave adequate predictions of evaporation and water content profiles, provided a field capacity measurement was taken. (Baker-IVI) W84-03227 SOIL WATER DESORPTION CURVES ESTI-

MATED FROM LIMITED DATA, Department of Agriculture, Ottawa (Ontario). Land Resource Research Inst. R. de Jong.

Canadian Journal of Soil Science, Vol. 63, No. 4, 697-703, November, 1983. 2 Fig. 3 Tab, 16 Ref.

Descriptors: \*Soil water, \*Desorption, Estimating, Mathematical equations, Canada, Soil properties.

Measuring soil water desorption curves is time consuming, tedious and expensive. The soil water desorption curve, modeled as a power curve, can be approximated from a limited number of measured water contents at specific tensions. Applicability of the model was tested on 90 soils. By forcing the soil water desorption curve through different measured water contents at various tensions, and by modifying different parameters, both the shape and the position of the curve could be altered considerably. Measurements at the two ex-tremes were the most important, if only two water contents were measured. The best results were obtained when the curve was fitted through three measured water contents, respectively, at satura-tion, at an intermediate (5.0-35.0 kPa) tension, and at a high tension (1500.0 kPa). (Baker-IVI) W84-03229 nsion, and

PERENNIAL RYEGRASS GROWTH, WATER USE, AND SOIL AERATION STATUS UNDER SOIL COMPACTION, Kansas State Univ., Manhattan. Dept. of Horticul-

ture.

For primary bibliographic entry see Field 2I. W84-03240

TILLAGE AND CULTURAL MANAGEMENT OF IRRIGATED POTATOES,

Dwa State Univ., Ames. Dept. of Agronomy. D. R. Buxton, and J. C. Zalewski. Agronomy Journal, Vol. 75, No. 2, p 219-225, March-April, 1983. 4 Fig. 5 Tab, 23 Ref.

Descriptors: \*Tillage, \*Cultural management, \*Irrigation, \*Potatoes, Soil compaction, Irrigation effects, Soil organic matter, Soil texture, Infiltration rate, Soil-water-plant relationships.

Many intensively row-cropped, irrigated soils are compacted and have slow water infiltration rates. Evaluating the relationship among soil compac-tion, water infiltration rates, and potato (Solanum tuberosum L.) yield and quality will help determine the influence of tillage and other practices on soil compaction, water infiltration rates, and potato response. Twenty-two commercial, irrigated potato fields were monitored and several tillage practices evaluated on soils from seven great groups. Soil compaction was evaluated by measur-ing penetrometer resistance. Although penetrometer resistance and water infiltration rates showed a large amount of variation in the 22 fields, they re not significantly correlated with each other were not significantly correlated with each other. The correlation coefficient between penetrometer resistance 0.2 m below furrows and tuber yield was 0.38. Water infiltration rate was not associated with tuber yield nor quality. In the 18 fields with less than 600 g/kg sand, soil texture had little association with water infiltration rates, however, association with water inflitration rates, nowever, soil organic matter greater than 12 g/kg was positively associated with water infiltration rates. In the 22 fields, number of years between successive potato crops accounted for 33% of the variation in tuber yield with greatest yields when at least 4 years occurred between potato crops. In replicated in the property of the potation of the property of the prope years occurred between potato crops. In replicated tillage experiments, chiseling reduced penetrometer resistance to a deeper depth than moldboard plowing. Chiseling did not result in greater water infiltration rates, tuber yield, nor tuber quality than plowing. Chiseling and plowing in combination showed no advantage over either practice alone. Additionally, chiseling bed centers showed no wield educate a preserve accepts and provided the control of t yield advantage over an unchiseled check in fields that were previously plowed even though penetrometer resistance was reduced by chiseling. This study indicates that with proper irrigation management some deep tillage operations can be eliminated by many growers. (Murphy-IVI) W84-03242

NUMERICAL ANALYSIS OF SOIL WATER MOVEMENT UNDER CONDITIONS OF RAPID INTERMITTENCY OF WATER APPLI-CATION

Banaras Hindu Univ., Varanasi (India). Dept. of Geophysics

M. Banerjee, and K. K. Watson.

Water Resources Research, Vol. 20, No. 1, p 119-125, January, 1984. 15 Fig. 6 Ref.

Descriptors: "Hysteresis, "Soil water, "Irrigation practices, Root zone, Wetting front, Sand, Permeability coefficient, Sprinkler irrigation, Infiltration,

When a sand material is subjected to a series of intermittent infiltration-redistribution cycles the hysteresis-affected material is limited to the surface horizons. Below this region, a zone of porous material exhibiting uniform water content and pressure head values develops. This zone is boundpressure head values develops. This zone is bound-ed at its lower end by the wet front and gradually lengthens as the cyclic wetting pattern continues. The development of the stable zone provides the basis for a simple in situ means of determining the hydraulic conductivity - water content relation-ship. The significance of the analysis in relation to sprinkler irrigation practice in regions of limited water supply is apparent. This is particularly the case where a fixed sprinkler system exists. If a control unit is introduced into the system, allowing control unit is introduced into the system, allowing the pulsed application of water, it is possible to control the rate of arrival of water to the root zone and generally balance this against the evapotran-spiration demands of the system. Such a procedure would minimize drainage through the root zone to the lower soil horizons. (Moore-IVI) W84-03418

EFFECT OF MIXED CATION SOLUTIONS ON HYDRAULIC SOIL PROPERTIES,

Haryana Agricultural Univ., Hissar (India). Dept. of Soils. R. S. Siyag, R. Pal, S. R. Poonia, and T. C.

Baruah

Agricultural Water Management, Vol. 6, No. 1, p 15-25, 1983. 8 Fig, 4 Tab, 15 Ref.

Descriptors: \*Permeability coefficient, \*Soil water, \*Diffusivity. Saturated flow, Unsaturated flow, Electrolytes, Sodium adsorption ratio, Clay loam, Sandy loam, Pore size.

Hydraulic conductivity (K) and soil water diffusivity (D) characterizing water flow under saturated and unsaturated conditions, respectively, were de-termined for a sandy loam and a clay loam soil, using water with different combinations of total electrolyte concentrations, C (i.e., 20, 40, 80, 125 and 250 meq/l) and sodium adsorption ratios (SAR). Both K and D increased with C and decrease with SAR. In low sodium adsorption ratio ranges (i.e., up to 20) the requirement of electrolyte concentration to maintain relative hydraulic conductivity = 0.5 was relatively more for sandy loam than for clay loam soil. However, the trend toam than for easy toam soil. However, the trenu for electrolyte concentration requirements for the two soils was reversed at high sodium adsorption ratios (i.e. > 20). A spline function was used to draw the best fitting line through the data points of horizontal adsorption experiments. The reduction in K of these soils in relation to SAR is attributed to swelling, dispersion and migration of clay parti-cles which result in the reorientation of soil particles and consequently affect the pore size distribu-tion. Both swelling and movement of clay particles cause blocking of water conducting pores and hence a decrease in K. (Moore-IVI) W84-03432

FUNCTIONING OF MOLE DRAINS IN CLAY

Agricultural Research Council, Wantage (England). Letcombe Lab.

M. J. Goss, G. L. Harris, and K. R. Howse. Agricultural Water Management, Vol. 6, No. 1, p 27-30, 1984. 1 Fig, 6 Ref.

Descriptors: \*Subsoil drains, \*Water table fluctua-tions, Drainage, Rainstorms, Clays, Soil properties,

#### Field 2-WATER CYCLE

#### Group 2G-Water In Soils

Fissures, Mole drains, Water management, Model studies.

Observations of water-table fluctuation and drainflow are reported from a field experiment on a heavy clay soil with replicated 'mole-drained' and undrained plots. During a particular rainfall event the deep drains were the principal collectors yielding 86% of drainage water on the drained plots. Interflow was the most important collector for the undrained plots yielding 76% of drainage water. A direct comparison was made of the flow from the mole drains with the flow from the topsoil without interaction. The depth to the water table below the soil surface was least at the same time for both treatments and more than 1 hr later than the peak flow from the drains or collectors. The time of peak drainflow was the same on the drained and undrained plots, suggesting that flow into the drains was largely influenced by movement in the topsoil. The principal route of water from the soil surface to the mole drains was not uniformly through the subsoil which had only a small volume of drainable pores at each depth. Thus removal by the closely spaced mole drains of only a small volume of water caused a large fall in the water flowed largely in the more porous Ap horizon for most of the recession and so required a much larger volume to be removed for a similar fall in the water table. (Baker-IVI)

ANALYZING FIELD-MEASURED SOIL-WATER PROPERTIES,

D. R. Nielsen, P. M. Tillotson, and S. R. Vieira. Agricultural Water Management, Vol. 6, No. 2/3, p 93-109, 1983. 7 Fig, 46 Ref.

Descriptors: \*Soil water, \*Statistical methods, Reviews, Stochastic process, Model studies, Spatial distribution, Spectral analysis, Correlation analysis, Mathematical studies.

A qualitative review is offered of statistical concepts useful in the field of agricultural sciences. In the area of spatial and temporal dependence attention is given to spatial autocorrelation, spatial cross-correlation, spectral analysis, cospectral phase angles and coherence, semivariograms and kriging, and cross-semivariograms and cokriging. Concerning deterministic versus stochastic equations information is presented concerning scaling and stochastic equations. Of paramount importance in this field is the identification of criteria for choosing deterministic rather than stochastic algorithms for ascertaining the behavior of water in field soils. (Baker-IVI)

USE OF SOIL SURVEY DATA TO SELECT MEASUREMENT TECHNIQUES FOR HY-DRAULIC CONDUCTIVITY, J. Bouma.

Agricultural Water Management, Vol. 6, No. 2/3, p 177-190, 1983. 4 Fig. 4 Tab, 29 Ref.

Descriptors: \*Permeability coefficient, \*Soil properties, Soil water, Physical properties, Macropores, Saturated soils, Unsaturated soils, Soil types.

The selection of proper physical-measurement techniques as a function of different soil and site conditions is examined. The conditions are such as can be derived from soil-survey information. A comparison is offered of different operational aspects of measurement methods. Some arbitrarily selected examples are presented to illustrate the importance of soil and site conditions for selecting methods for measuring hydraulic conductivity. Sample size, soil swelling, occurrence of macropores in both saturated and unsaturated soils, and soil profiles are considered. (Baker-IVI)

A HEURISTIC MODEL OF SOIL WATER REGIMES IN CLAY SOILS IN THE PRESENCE OF MOLE DRAINAGE,

A. C. Armstrong. Agricultural Water Management, Vol. 6, No. 2/3, p 191-201, 1983. 3 Fig. 1 Tab, 9 Ref.

Descriptors: \*Soil water, \*Drains, Mole drains, Drainage, Soil properties, Clays, Soil types, Heuristic model, Model studies.

Soil water regimes are considered as they affect agriculture either through affects on plant growth or on the farmer's ability to use the land. A clay soil is considered as a two phase system, in which there is rapid movement within a system of structural passages (macropores) which have a relatively low volume in the soil mass but a high conductivity, and a far more extensive but much less conductive system of micropores. The proposed model is intended as a heuristic device to explore the possibility of a two-phase model for predicting soil water regimes. Its criterion for success is the matching of observed and pedicted water table behavior and not the physical explanation it offers. The model divides into four major components: infiltration, water table modelling, the coupling model and surface storage. Preliminary results are offered using rainfall inputs for Okehampton in Devon running the model for a 200 day period from October to March using daily rainfall values. While a significant portion of the input to the micropore system is by infiltration from the macropores, this component does not dominate the response since it is only about 25% of the total input. A significant factor in maintaining high water tables very near the surface is the carry-over effect afforded by the storage of water on the surface. The implication must be that effective surface drainage, by removing this store, has a beneficial effect. (Baker-IVI)

REGIONAL FIELD STUDY OF THE SPATIAL VARIABILITY OF SELECTED SOIL PHYSICAL PROPERTIES.

A. G. Hornsby, J. M. Davidson, D. K. Cassel, and R. R. Bruce.

Agricultural Water Management, Vol. 6, No. 2/3, p 269-276, 1983. 2 Fig, 3 Tab, 11 Ref.

Descriptors: \*Soil properties, \*Spatial distribution, Physical properties, Soil water, Water management, Farming.

With increased interest in managing soil water for crop production in areas which rely primarily on rainfall to meet crop demands, a greater need exists to understand the spatial and temporal variability of soil hydraulic properties. This collection of field and lab data using standardized methods permits critical analysis of the appropriateness of the methods for a particular use and reveals those situations where the methods fail. The instantaneous profile method or the plane of zero flux method for determining in situ unsaturated hydraulic conductivity of field soils works well for most of the soil series examined in this study. Some difficulty was found in establishing a water saturated soil profile at some sites due to macropores which short-circuited the water through the profile and prevented the ponding process from thoroughly wetting the entire profile. A problem encountered at some sites was the inability to saturate the lower horizons which were located below a less permeable horizon and which usually had a higher clay content. Swelling of the undisturbed soil cores used to measure bulk density and the soil-water retention curves contributed to measurement errors of these two parameters. (Baker-IVI)

WHEAT ROOT GROWTH, GRAIN YIELD AND WATER UPTAKE AS INFLUENCED BY SOIL WATER REGIME AND DEPTH OF NITROGEN PLACEMENT IN A LOAMY SAND SOIL,

Indian Grassland and Fodder Research Inst. Jhansi. For primary bibliographic entry see Field 2I. PROBABILITY OF WATERLOGGING ESTI-MATED FROM HISTORICAL RAINFALL RECORDS,

Ministry of Agriculture, Fisheries and Food, Cambridge (England). Field Drainage Experiment Unit.

C. W. Dennis, and J. Grindley. Agricultural Water Management, Vol. 6, No. 4, p 397-401, 1983. 1 Fig, 2 Tab, 7 Ref.

Descriptors: \*Waterlogging, \*Rainfall, \*Probability, Soil water, Drainage, Cambridge, England.

The usual method of operating the lysimeter facility at the Letcombe Laboratory (Great Britain) has been to apply large amounts of artificial rainfall over a short period of time in order to achieve the onset of sharp, well defined waterlogging events. This has presented the problem of assessing the likelihood in the field of the various simulated rainfall applications which the experimental program has used. The probability of waterlogging occurring on a given date may be calculated from meteorological records, provided that certain soil properties are known. In essence the method involves ascertaining the return period for a given fraction (either greater or smaller than unity) of the average rainfall in the period between arrival at or departure from field capacity and the particular date of interest. Due to the normal presence of some sort of drainage, the values obtained may be regarded as minima. The area around Cambridge, England is used in a demonstration of the method. (Moore-IVI)

DIRECT PARAMETER IDENTIFICATION OF FRACTURED POROUS MEDIUM,

Princeton Univ., NJ. Dept. of Civil Engineering. V. V. Nguyen.

Advances in Water Resources, Vol. 6, p 11-14, March, 1983. 3 Fig, 1 Tab, 6 Ref. Department of Energy contract DE-AC03-80SF11489.

Descriptors: \*Porosity, Piezo-conductivity, Conductivity, Transmissivity, Mathematical equations, Model studies.

A direct method of parameter identification for a fracture porous medium can be formulated. The coefficient of piezo-conductivity and the virtual fracture transmissivity can be determined using a combination of graphical methods and approximate formulae. Field calculation provides a practical demonstration of the proposed approach. In contrast to the type-curve approaches currently known in the literature, this simple procedure may be viewed as an alternative to field practitioners. (Baker-IVI)

TRANSPORT OF WATER IN FROZEN SOIL. II. EFFECTS OF ICE ON THE TRANSPORT OF WATER UNDER ISOTHERMAL CONDITIONS.

Cold Regions Research and Engineering Lab., Hanover, NH.

Y. Nakano, A. Tice, J. Oliphant, and T. Jenkins. Advances in Water Resources, Vol. 6, No. 1, p 15-26, March, 1983. 11 Fig, 2 Tab, 16 Ref.

Descriptors: \*Water transport, \*Soil water, \*Frozen ground, Ice, Mathematical analysis, Soil properties, Clays.

It is known that water in frozen soil generally exists in three phases: vapor, liquid (absorbed water) and ice. In liquid phase water in frozen soil is often referred to as unfrozen water. The unfrozen water content mainly depends on the soil type and temperature although unfrozen water versus temperature curves usually exhibit minor hysteresis depending on cooling and warming cycles. Experimental results obtained using Morin clay at minus 1.0 degrees C, showed that the presence of ice significantly affects the transport of water. A strong correlation exists between the flux of water and the gradient of total water content. A theoretical analysis of the experimental results and a dis-

#### Lakes-Group 2H

cussion of a possible mechanism for water transport in frozen soil are presented. (Baker-IVI) W84-03458

THE SOIL-MOISTURE ZONE IN A PHYSICALLY-BASED HYDROLOGIC MODEL, Waterloopkundig Lab., Delft (Netherlands).

B. H. Gilding. Advances in Water Resources, Vol. 6, No. 1, p 36-43, March, 1983. 6 Fig, 24 Ref.

Descriptors: \*Hydrologic models, \*Soil water, \*Aeration zone, Mathematical models, Unsaturated flow, Soil-water-plant relationships.

An approach to modelling the unsaturated soil-An approach to moderning the disastituted some moisture zone in the framework of an integrated physically-based hydrologic response model was developed. The subsurface flow regime may be viewed as two separate entities: a saturated flow viewed as two separate entities: a saturated flow system which may be modelled by standard two-dimensional regional techniques, and a single over-lying unsaturated zone in which the flow is essen-tially vertical. Coupling takes place via the defini-tion of saturation at the lower boundary of the unsaturated zone, and via a conservative water balance. Attention is focused on the computational procedure for the unsaturated zone as a self-con-tained module. The major difficulties are the defi-nition of the interface between the saturated and nition of the interface between the saturated and unsaturated zones, the nonlinear character of the equation used to describe unsaturated flow, the inclusion of realistic atmospheric boundary conditions, and, the interaction between water uptake by plants and available soil-moisture. The complete numerical technique is non-iterative, and is based upon the use of a predictor and corrector at each time-step. The computational procedure yields the soil-moisture distribution, actual infiltration or surface evaporation, and actual water uptake by plants as functions of time with specified initial and potential values as input. (Moore-IVI) W84-03459

SOIL MORPHOLOGY AND WATER REGIMES IN 3 RECENT ALLUVIAL SOILS ON THE TAIERI PLAINS, SOUTH ISLAND, NEW ZEA-

Department of Scientific and Industrial Research,

Department of Scientific and Industrial Research, Dunctin (New Zealand). Soil Bureau. S. M. Smith, and F. G. Beecroft. New Zealand Journal of Science, Vol. 26, No. 3, p 403-411, 1983. 2 Fig. 3 Tab, 18 Ref, 1 Append.

Descriptors: \*Soil water, \*Soil morphology, \*South Island, \*New Zealand, Soil water table, Seasonal variation, Matrix color.

An assessment of soil morphology and water regimes of 3 recent alluvial soils on the Taieri Plains, South Island, New Zealand, is described. The pattern of soil water table fluctuations follows a yearly sigmoidal cycle. With increased duration of saturation, mottles tend to decrease in size and abundance and have more diffuse boundaries. The matrix colors of the soil horizons, in conjunction with the nature of the mottles, broadly reflect the with the nature of the motitues, broadly reflect the different moisture regimes at the 3 sites although the distinction between imperfectly and poorly drained soils is not clear. Moisture regimes as used by the Soil Survey of England and Wales successfully separated the soils into distinctive (quantified) classes. Soil Taxonomy separated the 2 wetter members of the sequence, but does not quantify the duration of saturation. Further research is needed to develop a system of soil moisture regime classification in New Zealand if soil survey interpretacation in New Zealand if soil survey interpreta-tions are to be expanded. (Author's abstract) W84-03485

#### 2H. Lakes

THE NATURAL HISTORY OF A NEARCTIC TEMPORARY POND IN ONTARIO WITH REMARKS ON CONTINENTAL VARIATION IN

SUCH HABITATS,
Toronto Unv. (Ontario). Div. of Life Sciences.
D. D. Williams.

Internationale Revue der Gesamten Hydrobiologie, Vol. 68, No. 2, p 239-253, 1983. 5 Fig, 1 Tab,

Descriptors: \*Invertebrates, \*Ponds, \*Temporary ponds, Population dynamics, Seasonal variations, Ontario, British Columbia, Model studies, Fauna.

Physical, chemical and faunal characteristics of a rinystal, circumata and natural characteristics of a temporary vernal pond in southern Ontario, Canada are given. As the pond water evaporated temperature and conductivity rose while pH varied. Ninety-eight taxa were identified which showed seasonal succession over the annual cycle of the nond. Five recognizably distinct faunal showed seasonal succession over the annual cycle of the pond. Five recognizably distinct faunal groups, based on time of appearance and period of activity, were apparent. Group 1 animals were found during the entire aquatic phase. Group 2 animals were active within days of the pond filling in the spring and completed their life cycle within 4-6 weeks. Group 3 animals appeared 2-5 weeks after filling and typically took 5 weeks to mature. Species in Group 4 were evident only 2-3 week before the pond dried up and exhibited rapid growth. Group 5 animals appeared in the dry phase and included primarily terrestrial and riparian species. Community composition is analyzed in terms of trophic status of each taxon. This indicates shifts which were appropriate for seasonal terms of trophic status of each taxon. This indicates shifts which were appropriate for seasonal changes in the pond's potential food resources. The taxonomic composition of the spring time fauna of this pond was compared with that of a very similar pond 2,400 km to the west, on Vancouver Island, British Columbia. The number of species in each major taxon was frequently identical in the two ponds. In addition, the faunas had 23 genera and 6 species in common. These two faunas are compared with a predictive model of the fauna compliment of annual temporary pools. (Baker-IVI) W84-02952

PELAGIC DIATOM POPULATIONS LENTIC FRESHWATER MICROCOSMS,

California Univ., Berkeley. Lawrence Berkeley

J. Harte, D. Levy, and J. T. Rees. Internationale Revue der Gesamten Hydrobiologie, Vol. 68, No. 2, p 255-267, 1983. 3 Fig, 5 Tab, 23 Ref.

Descriptors: \*Diatoms, \*Population dynamics, \*Lentic environment, Phytoplankton, Comparison studies, Epilimnion.

Three experiments, involving simultaneous monitoring of selected biological and chemical parameters in 50 I laboratory microcosms and the epilimia of their parent mervoirs, from the autumn of 1978 to the winter of 1980 (lasting 8-13 weeks), secretained the degree of similarity between laboratory and the degree of similarity between laboratory and the degree of similarity between laboratory. nia of their parent Taservoirs, from the aturum of 1978 to the winter of 1980 (lasting 8-13 weeks), ascertained the degree of similarity between laboratory and field systems. Microcosm dynamics, specifically diatom dynamics, most closely paralleled that found in reservoirs during late spring and early summer, a time of thermal stratification. During winter months when thermal stratification was absent or less pronounced, microcosm diatom populations diverged significantly from reservoir populations within 24 days. Microcosm design and operating conditions have a major bearing on microcosm usefulness for environmental ass (Murphy-IVI)

PRODUCTION AND ECOLOGY OF BENTHIC CHIRONOMID LARVAE (DIPTERA) IN LAKE HAYES, NEW ZEALAND, A WARM-MONO-MICTIC EUTROPHIC LAKE, Otago Univ., Dunedin (New Zealand). Dept. of

Zoology. A. A. Graham, and C. W. Burns. Internationale Revue der Gesamten Hydrobiologie, Vol. 68, No. 3, p 351-377, 1983. 10 Fig, 11 Tab, 56 Ref.

Descriptors: \*Chironomid larvae, \*Lake Hayes, \*New Zealand, \*Eutrophic Lake, Midges, Population dynamics, Benthic fauna, Phytoplankton, Organic matter, Ecological distribution, Aquatic productivity.

The benthic fauna of eutrophic lakes is usually ominated by chironomial larvae which, by their burrowing, respiration and excretion, may aid nu-trient cycling in lakes and are also important as fais food. From December 1973 to March 1975 the mean annual production of the two dominant spe-cies, Chironomus zealandicus and Chironomus sp. a, was 29.2 g/sq m dry weight which is approxi-mately 4.3% of the average annual phytoplankton production in the lake. A high annual P/B ratio of 18.5 is consistent with the multivoltine life cycle of C. zealandicus. Larval chironomid production in the second summer when Anabaena blooms were absent was only one quarter of that in the first assent was only one quarter of that in the first summer and is consistent with the hypothesis that the production of benthic chironomids in Lake Hayes is closely linked to that of the phytoplankton through the sedimentation of autochthonous organic matter. (Murphy-IVI) W84\_02955

ESTIMATES OF MICROBIAL POPULATIONS INVOLVED IN THE N CYCLE AND THEIR ACTIVITY IN WATER AND SEDIMENTS OF FISH FARMING PONDS UNDER MONO- AND POLYCULTURE SYSTEMS IN INDIA,

Kalyani Univ. (India). Dept. of Zoology.

B. B. Jana, and S. K. Roy. Internationale Revue der Gesamten Hydrobiologie, Vol. 68, No. 4, p 581-590, 1983. 6 Fig. 22 Ref. Indian Council of Agricultural Research grant 11(8)-76-ASR(I).

Descriptors: \*Bacteria, \*Population density, \*Nitrogen cycle, \*Fish farming, \*Fish ponds, \*Monoculture, \*Polyculture, Ammonification, Nitrifica-

Spatial differences in the microbial density of a monifying, protein mineralizing, nitrogen fixing and nitrifying bacteria, and the rates of ammonification and nitrification (natural and potential) in water and sediments of four fish ponds used for water and sediments of lour han points used for traditional, mono- and polyculture systems of fish farming were related to the fish culturing practices adopted. The seasonal variation of ammonifying bacteria was positively correlated with the NH4-N level in the water. The natural and potential capacity to generate both nitrite and nitrate in these water bodies was strongly correlated with the concentrations of the different forms of inorganic ni-trogen present. The rates of NO2-N and NO3-N formation occurring in these fish ponds were directly proportional to the amount of dissolved oxygen and pH of the environment, respectively. (Murphy-IVI) W84-02958

A STUDY ON THE MACRO-ZOOBENTHOS AND THE PHYSICO-CHEMICAL CHARAC-TERISTICS OF THE BOTTOM OF BAKHIRA LAKE, UTTAR PRADESH, INDIA,

Gorakhpur Univ. (India). Dept. of Zoology. K. Pandey, R. Shyam, S. Prasad, and H. S. Chaudhry.

Internationale Revue der Gesamten Hydrobiologie, Vol. 68, No. 4, p 591-597, 1983. 2 Fig, 2 Tab, gie, Vo 22 Ref.

Descriptors: \*Benthic fauna, \*Physicochemical properties, \*Bottom sampling, \*Bakhira Lake, Population dynamics, Bottom water.

Bakhira Lake is the largest man-made lake of East-ern Uttar Pradesh. It is utilized for Boro (coarse paddy) cultivation, irrigation and fishing by poor village farmers. The lake is a combination of ten tals (large basins), and has no regular gradation in depth. Hydrographical features, qualitative and quantitative composition of the macro-zoobenthos, and the hydrographical characteristics of the and the physico-chemical characteristics of the bottom water and sediment were studied from October 1976 to April 1977. Mollusks, insects, October 1976 to April 1977. Mollusks, insects, ostracods, annelids, nematodes and crusaceans are the main groups of zoobenthos. Mollusks together with insects dominate the benthic fauna (95.2 to 96.4% of numbers). The average density of macrozoobenthos is more or less inversely related to the total alkalinity of the bottom water. Mollusks showed a positive correlation to temperature and a

#### **Group 2H-Lakes**

negative correlation to insect density. (Murphy-IVI) W84-02959

THE DISTRIBUTION OF DESMOGNATHINE LARVAE (AMPHIBIA: PLETHODONTIDAE)
IN COAL SURFACE MINE IMPACTED
STREAMS OF THE CUMBERLAND PLATEAU, USA,

Tulsa Univ., OK. Faculty of Natural Sciences. Journal of Freshwater Ecology, Vol. 2, No. 1, p 13-23, March, 1983. 3 Fig. 2 Tab, 32 Ref.

Descriptors: \*Streams, \*Acidity, \*Benthic environ-ment, Population dynamics, Water pollution ef-fects, Mine drainage, Mine wastes, Iron pyrite, Metals, Turbidity, Shading, Light intensity, Vege-

Selected water quality parameters of streams in the Selected water quanty parameters of status in the Cumberland Plateau area of Kentucky, Tennessee, and Alabama and their relationship to the occurrence of desmognathine larvae are considered. Higher densities of larvae were found in streams with greater than 80% overhead vegetation (less than 20% direct insolation). These streams with high overhead vegetation, therefore shaded, values night overhead vegetation, incretore shaded, values were also those of the lowest stream order and discharge. There were no trends observed with regard to temperature of the water and dissolved oxygen concentrations, which were near to saturation levels for all streams studied. (Baker-IVI) W84-02961

THE DESMIDS AND PHYSICAL CHARAC-TERISTICS OF 100 LAKES IN NORTHEAST-ERN PENNSYLVANIA,

Wilkes Coll, Wilkes Barre, PA.
C. B. Reif, B. B. Smith, and A. Case.
Journal of Freshwater Ecology, Vol. 2, No. 1, p
25-36, March, 1983. 4 Tab, 40 Ref.

Descriptors: \*Lakes, \*Species diversity, \*Acid rain, \*Desmids, \*Pennsylvania, Water pollution effects, Bear Creek, Acidity, Sodium, Potassium, Magnesium, Calcium, Conductivity.

Paired samples taken from 100 lakes during July of 1980 were examined for desmids and analyzed chemically. The lakes lie in an area roughly one hundred km by fifty km within northeastern Pennsylvania. Elevations above mean sea level range from 289 m to 624 m. Harveys Lake, with an area of 280 hectares, is the largest natural lake, by volume, in the state. Lakes Henry and Ladore also exceed 100 hectares but the other 97 were smaller. From each lake two samples were taken in the littoral zone close to vascular aquatic plants. Simple linear regression analyses comparing desmids with pH, conductivity, alkalinity, calcium, magnesium, sodium, and potassium indicated very little statistical correlation between numbers of species and any single chemical factor. Stepwise regression for pairs of chemical values produced highest R-square for pH and magnesium but not positively significant. (Baker-IVI) W84-02%2

4

FORAGE FISH ASSEMBLAGES IN THE BRAZOS RIVER UPSTREAM AND DOWN-STREAM FROM POSSUM KINGDOM RESER-VOIR, TEXAS, North Texas State Univ., Denton. Inst. of Applied

K. A. Anderson, T. L. Beitinger, and E. G.

Journal of Freshwater Ecology, Vol. 2, No. 1, p 81-88, March, 1983. 1 Fig, 2 Tab, 16 Ref. OWRT grant (B-22-TEX).

Descriptors: \*Forage Fishes, \*Population dynamics, \*Brazos River, \*Possum Kingdom Reservoir, Fish populations, Ecosystems.

River impoundments can affect downstream biological communities by changing temperature re-gimes, flow rates, substrate, water quality and nu-trient availability. Metabolism of dissolved sub-stances in lentic waters can lead to reduced nutri-

ent availability and changes in water solute concentrations in water discharged from reservoirs. The forage fish assemblages of the Brazos River The forage fish assemblages of the Brazos River was sampled at one location above and four locations below Possum Kingdom Reservoir each month for one year. A total of 13,936 individuals representing 18 species, 14 genera and five families were collected. Five of these species, Notropis stramineus, Notropis atherinoides, Hybognathus placitus, Hybogsis aestivalis and Cyprinodon ruberflutivities uses found colly unstream from Possum Kingdom Reservoir. Hybognatus placitus accounted for 45% of fish captured at the upstream site. In contrast, nine species were collected exclusively in the tailwaters, including Etheostoma spectabile, Percina sciera, Campostoma anomalum, Notropis venustus, Pimephales notatus, Labi-desthes sicculus and Fundulus notatus. Only four desthes sicculus and Fundulus notatus. Only four species were obtained at all five stations — Gambusia affinis, Menidia beryllina, Pimephales vigilax and Notropis lutrensis. N. lutrensis was the most common tailwater species equalling 87.9% of the total downstream catch. Median species diversity indices ranged from 0.129 to 0.451 for the five stations with the highest value of the uncertainty of the control stations, with the highest value at the upstream station. Coefficients of biotic similarity ranged station. Coefficients of olocic similarity ranged from 0.20 to 0.62, with the upstream station clearly being the most dissimilar. These findings are dis-cussed relative to environmental effects of hypo-limentic release of reservoir waters. (Murphy-IVI) W84-02964

CHANGES IN THE CHIRONOMID (DIPTERA: CHIRONOMIDAE) FAUNA OF LAUREL CREEK RESERVOIR, WATERLOO, ONTARIO, Waterloo Univ. (Ontario). Dept. of Biology. T. W. Sephton, B. A. Hicks, C. H. Fernando, and

C. G. Paterson Journal of Freshwater Ecology, Vol. 2, No. 1, p 89-102, March, 1983. 3 Fig, 5 Tab, 49 Ref. NSERC grants A-3478 and A-6299.

Descriptors: \*Population dynamics, \*Laurel Creek Reservoir, \*Waterloo, \*Ontario, \*Chironomids, Reservoirs, Eutrophication, Trophic level, Dissolved oxygen

Qualitative and quantitative changes in the chironomid fauna of Laurel Creek Reservoir are present ed as they were determined over the 13 years of its ed as they were determined over the 13 years of its existence. A substantial decrease is noted in the average numerical abundance from 1967 to 1968, from 6303/sq m to a373/sq m, and it has remained stable since 1975 to 1980. Distinct changes were noted in the faunan numerical abundance, although the genera have remained the same. In 1967, the Chironomini comprised 95% of the total throughout the year. In 1968, the Chironomini dominated with 68%, the Tanytarsini increased to 24% and the Tanytodings at 6%, and Orthocladinae at 2%. the Tanypodinae at 6% and Orthocladiinae at 2% remained low. In 1975 the Chironomini accounted remained low. In 1975 the Chironomini accounted for 72% and the Tanypodinae increased to 21%, the Tanytarsini decreased to 5%, and the Orthocladiinae remained low at 2%. By 1980 the Tanypodinae had become dominant at 60% while the Chironomini had become dominant at 60% while the Chironomini had becreased to 38%. The Tanytarsini and Orthocladiinae were insignificant at 1% each. The decreased standing stock and changes in each. The decreased standing stock and changes in the dominance hierarchy of the chironomid fauna are associated with changes in the trophic level of the substrate conditions and bottom oxygen levels of the reservoir. Laurel Creek Reservoir has not entered a state of advanced eutrophy. (Baker-IVI)

ALKALINITY, DISCHARGE, AVERAGE VE-LOCITY, AND INVERTEBRATE DRIFT CON-CENTRATION IN SUBARCTIC ALASKAN STREAMS.

a Univ., Fairbanks. Inst. of Water Resources. J. D. LaPerriere. Journal of Freshwater Ecology, Vol. 2, No. 2, p 141-151, July, 1983. 4 Fig, 1 Tab, 23 Ref.

Descriptors: \*Invertebrates, \*Streams, \*Alaska, Alkalinity, Velocity, Sediment transport, Invertebrate drift, Insects, Flow discharge.

The associations of alkalinity, current and invertebrate drift among 13 streams were measured in

subarctic Alaska. A significant positive correlation was noted between alkalinity and drift concentrations expressed as numbers per unit volume. Significant inverse relations were found between stream discharge and drift concentration expressed as either numbers or weight. This dilution was to be expected as stream wetted perimeter, the source of invertebrates to drift, increases as approximately the square root of the discharge. Multiple regression analysis also showed a positive relation bethe square root of the discharge. Multiple regression analysis also showed a positive relation between stream average velocity and drift concentrations. Invertebrate drift was seen, therefore, to be somewhat analogous to sediment transport in streams. Most of the drift samples were numerically dominated by Diptera. Ephemeroptera usually were next in numbers, and Trichoptera and Plecoptera alternated in being third most numerous. (Baker-IVI)

LIMNOLOGICAL FEATURES OF NORTHWESTERN FLORIDA LAKES,

Florida Univ., Gainesville, Inst. of Food and Agri-D. E. Canfield, Jr., M. J. Maceina, L. M. Hodgson,

and K. A. Langeland. Journal of Freshwater Ecology, Vol. 2, No. 1, p 67-79, March, 1983. 2 Fig, 7 Tab, 34 Ref.

Descriptors: \*Limnology, \*Sandhill lakes, \*Florida, Mirrow Lake, Lake McKenzie, Turkey Pen Pond, Compass Lake, Round Lake, Crystal Lake, Dunford Pond, Gap Pond, Merial Lake, Chlorophyll, Chemical analysis, Acidity, Water quality, Oligotrophic lakes.

A limnological survey was undertaken of some sandhill lakes in Florida to assess their present limnological conditions. Nine lakes in all were examined. Mean depth ranged from 6.3 to 27 m. Secchi disc values ranged from 3.2 to 8.1 m. Thermal stratification occurred in all lakes. Chemically mal stratification occurred in all lakes. Chemically the lakes were characterized as acidic, soft-water lakes of low mineral content. Average total phosphorus values ranged from 3.1 to 10 mg/cu m, and average chlorophyll a values ranged from 0.5 to 1.4 mg/cu m. These are among the most oligotrophic lakes in Florida. It is felt that anthropogenic activities have had very little influence on these present conditions. The Lakes studied were Compass Lake, Crystal Lake, Dunford Pond, Gap Pond, Lake McKenzie, Merial Lake, Mirrow Lake, Round Lake, and Turkey Pen Pond. (Baker-W84-02971

COMMENTS CONCERNING 'CONVECTION PATTERNS IN A POND',
Hawaii Univ., Honolulu. Dept. of Oceanography.

For primary bibliographic entry see Field 2C W84-02981

NITROGEN FIXATION AND PHOSPHORUS TURNOVER IN A HYPERTROPHIC PRAIRIE

National Water Research Inst., Burlington (Ontar-

National Water Research inst., Durington (Omario). Aquatic Ecology Div.
B. G. Brownlee, and T. P. Murphy.
Canadian Journal of Fisheries and Aquatic Sciences, Vol. 40, No. 11, p 1853-1860, November, 1983.
3 Fig. 5 Tab, 27 Ref.

Descriptors: \*Nitrogen fixation, \*Phosphorus removal, \*Hypertrophic lakes, Carbonates, Ammonia, Nitrogen cycle, Algae, Aphanizomenon, Manitoba, Eutrophication, Prairies.

Nitrogen fixation by Aphanizomenon flos-aquae in a prairie lake in southwestern Manitoba was dependent on the light intensity and in situ oxygen concentrations. The mean molar ratio of acetylene reduction to nitrogen reduction was 5.8:1. High external ammonium concentrations did not appear to inhibit nitrogen fixation over the short term. Nitrogen fixation was not directly initiated by the bloom collapse. The sequence of ammonia volatilization and nitrogen fixation was triggered by the bloom collapse and the bloom collapse was caused by coprecipitation of orthophosphate with carbonates. PO4 turnover was most rapid during periods when the lake was opalescent, presumable due to carbonate precipitation. (Murphy-IVI) W84-03015

A NEW APPROACH TO ESTIMATING POPU-LATIONS BY THE REMOVAL METHOD, Department of Fisheries and Oceans, Nanaimo (British Columbia). Pacific Biological Station.

Canadian Journal of Fisheries and Aquatic Science es, Vol. 40, No. 12, p 2153-2169, December, 1983. 2 Fig, 5 Tab, 17 Ref, 5 Append.

Descriptors: \*Fish populations, \*Model studies, Populations, Mathematical models, New Bruns-wick, Estimating.

This new approach to the use of removal data in estimating the size of a population of fish or other animals admits a variety of assumptions on how catchability varies among fishings including the assumption of constant catchability. The methods assumption of constant catchability. The methods hinge on maximum likelihood estimation, and can be used both to decide objectively if the data justify rejecting constant catchability and to determine confidence intervals for the parameters. A new method of assigning confidence to the population estimate points out problems with methods currently available in the literature. The theory is applied both to data in historical literature and recent data from streams in New Brunswick. applied both to data in historical literature and recent data from streams in New Brunswick, Canada, which demonstrate that constant catchability can frequently lead to serious errors in data interpretation. In some cases, the conclusion that the population size is well known may be blatantly false, and reasonable estimates may be impossible without further data. (Murphy-IVI) W84\_03022

A STOCHASTIC AGE-STRUCTURED POPULA-TION MODEL OF STRIPED BASS (MORONE SAXATILIS) IN THE POTOMAC RIVER, Rockefeller Univ., New York. J. E. Cohen, S. W. Christensen, and C. P. Goodwar.

J. E. Conen, S. C. Conen, S. C. Conen, S. C. Canadian Journal of Fisheries and Aquatic Sciences, Vol. 40, No. 12, p. 2170-2183, December, 1983. 1 Fig. 2 Tab, 37 Ref. NCF grant DEB80-11026, NIMH grant 5T32MH14581-06.

Descriptors: \*Stochastic process, \*Fish popula-tions, \*Bass, \*Potomac River, Morone, Mathemati-cal models, Fish management, Statistical analysis,

Deterministic age-structured models of fish populations neglect apparently stochastic fluctuations in the catch per unit effort of yearlings and of adult fish. A model is needed for an age-structured population in which the survival and egg-laying are constant. For such a stochastic model, two measures of the long-term population growth rate are the average growth rate of the population size and the growth rate of the average population size. Both measures are computed analytically for a simplified model representing only eggs and reproductive adults. For a model of the striped bass ductive adults. For a model of the striped bass population spawning in the Potomac River, both point and interval estimates of the growth rate of point and interval estimates of the growth rate of the average population size are computed. These models can be used as a framework for modeling stochastic variation of vital rates in real age-structured populations. (Murphy-IVI) W84-03023

MODEL OF MISSISSIPPI RIVER POOL: DIS-

MODEL OF MISSISSIPPI RIVER POOL: DIS-SOLVED OXYGEN, Rutgers - The State Univ., Piscataway, NJ. Dept. of Civil and Environmental Engineering. A. C. Demetracopoulos, and H. G. Stefan. Journal of Environmental Engineering, Vol. 109, No. 5, p 1020-1034, October, 1983. 8 Fig, 33 Ref.

Descriptors: \*Mathematical models, \*Mississippi River pool, \*Dissolved oxygen, Photosynthesis, Respiration, Biochemistry, Biomass, Hydrologic models, Hydraulic transportation.

Dissolved oxygen (DO) describes the general health of a water body and is a quality varible that

reflects the capacity of the system to support a balanced aquatic habitat. Biochemical oxygen demanding material (BOD) suspended or dissolved in the water (including waste), oxygen demanding material on the river bottom (Sedimentary oxygen demand, SOD) and respiratory requirements of the phytoplankton are the primary sink terms utilizing DO in a natural water body. The source/sink terms are very important for dissolved oxygen under low summer flow conditions. A simulation of dissolved oxygen (DO) dynamics and of biomass is incorporated in a dynamic wind and gravity driven hydrologic transport model. Photosynthesis introduced a diurnal cycle on the dissolved oxygen concentration, wich was sometimes very noticeable and sometimes obscured by other physical and biochemical processes. (Murphy-IVI)

GAS-FILM COEFFICIENTS FOR STREAMS,

Geological Survey, NSTL Station, MS. R. E. Rathbun, and D. Y. Tai. Journal of Environmental Engineering, Vol. 109, No. 5, p 1111-1127, October, 1983. 1 Fig, 2 Tab, 36

Descriptors: \*Gas-film coefficients, Streams, Mathematical equations, Prediction, Organic compounds, Organic loading, Volatilization, Fate of

Understanding the volatilization process is necessary for predicting correctly the fate of many organic compounds in streams and rivers. The volatization is frequently described by the two-film model. The film coefficient is a function of wind-speed and water temperature. The dependence of the coefficient on windspeed is determined from published information on the evaporation of water from a canal. The dependence of the coefficient on temperature is determined from laboratory studies on the evaporation of water. Procedures for adjusting the coefficients for different organic solutes are based on the molecular diffusion coefficient and based on the molecular diffusion coefficient and the molecular weight. The molecular weight prothe molecular weight. The molecular weight pro-cedure is easiest to use because of the availability of molecular weights. However, the theoretical basis of the procedure is questionable. The diffu-sion coefficient procedure is supported by consid-erable data. Questions, however, remain regarding the exact dependence of the film coefficient on the diffusion coefficient. The diffusion coefficient pro-cedure, with a 10.68 power demediates should cedure with a 0.68-power dependence should be used when precise estimate of the gas-film coefficient are needed and the molecular weight procedure be used when only approximate estimates are needed. (Murphy-IVI)

RESERVOIR CIRCULATION PATTERNS AND

Georgia Inst. of Tech., Atlanta. School of Civil

B. R. Kim, J. M. Higgins, and D. J. Bruggink. Journal of Environmental Engineering, Vol. 109, No. 6, p 1284-1293, December, 1983. 4 Fig, 1 Tab, 5 Ref.

Descriptors: \*Reservoirs, \*Water circulation, \*Water quality, Model studies, Mathematical models, Hypolimnion, Metalimnion, Wastewater outfall, Wastewater dilution, Hydrodynamics, Hydrological regime.

A two-dimensional hydrodynamic-temperature model examines the similarities between circulation patterns and observed water quality phenomena in Cherokee Reservoir. A circulation pattern, involving reverse bottom flows which occurred during March through July, most likely influenced high March through July, most likely influenced high fecal coliform concentrations in the water supply intake (located in the reservoir upstream of a wastewater outfall), depressed dissolved oxygen concentrations in the metalimnion and the development of dissolved oxygen depletion in the hypolimion. The potential effects of reservoir circulation suggest that reservoir operations might be used as one means of influencing water quality profiles within the reservoir. (Murphy-IVI) W84-03094

PHYTOPLANKTON MODELING IN THE EM-BAYMENTS OF LAKES.

National Taiwan Univ., Taipei. Dept. of Civil En-

gineering. J.-T. Kuo, and R. V. Thoma

Journal of Environmental Engineering, Vol. 109, No. 6, p 1311-1332, December, 1983. 11 Fig, 4 Tab, 29 Ref. EPA grant R803680030.

Descriptors: "Phytoplankton, "Mathematical models, "Lake embayments, Water quality, Finite element method, Comparison studies, Hydrodynamics, Water circulation, Rochester embayment,

A steady-state, finite-element lake circulation model generates mean circulation patterns in homogeneous lakes. This coupled model applied to Rochester Embayment, Lake Ontario during the nonstratification period and to Saginaw Bay, Lake Huron, has the advantage of reducing a considerable amount of computer time when compared to the use of a transient hydrodynamic model for water quality modeling. The model can calculate large-scale dispersion and turbulent exchange coefficients from detailed velocities calculated from the finer-scale lake circulation model around the coarser water quality segments. Water current outputs er water quality segments. Water current outputs and constituent concentration are sensitive to the change of vertical eddy viscosity, drag coefficient on the water surface, and wind data for the circula-tion model. (Murphy-IVI) W84\_03005

REAERATION AND VERTICAL DIFFUSION OF LAKE OXYGEN,

Johns Hopkins Univ., Baltimore, MD. Dept. of Geography and Environmental Engineering. W. J. Snodgrass.

Journal of Environmental Engineering, Vol. 109, No. 6, p 1419-1423, December, 1983. 2 Tab, 15

Descriptors: \*Lakes, \*Aeration, Oxygen, Diffusion, Mathematical study, Air-water interfaces, Dissolved oxygen.

The interaction between the reaeration coefficient of oxygen across the atmosphere-water interface, k (m/day), and the veritcal diffusivity coefficient in the surface waters of the lakes and reservoirs, D the surface waters of the lakes and reservoirs, D (sq m/day), may act as controllers upon the oxygen profile. Factors influencing the shape and sensitivity of oxygen profiles of epilimnetic waters analyzed quantitatively using steady-state models was prompted by discrepancies in the sensitivity of oxygen model predictions to variations in the reaeration coefficient. For example, an oxygen model is expected to be insensitive to a reaeration coefficient greater than 1 m/day if the vertical diffusivity coefficient is less than ca 1 sq m/day. The influence of other combinations of reaeration coefficient and vertical transport rate upon observed oxygen concentrations can be analyzed using models expressed. (Murphy-IVI) W84-03098

USE OF TIME-SERIES ANALYSIS TO DEM-ONSTRATE ADVECTION RATES OF DIFFER-ENT VARIABLES IN A SMALL LAKE,

McMaster Univ., Hamilton (Ontario). Dept. of Bi-

ology.
A. M. Trimbee, and G. P. Harris.
Journal of Plankton Research, Vol. 5, No. 6, p 819-833, 1983. 11 Fig. 1 Tab, 28 Ref.

Descriptors: \*Time series analysis, \*Advection, \*Multivariable analysis, Algal growth, Interfaces, Weather, Phosphorus, Guelph Lake.

In algal ecology, attempts to seek direct correla-In algal ecology, attempts to seek direct correla-tions between environmental factors and algal abundance at one point in time or space will fail if non-equilibrium conditions occur and time lags exist between the environmental change and the phytoplankton response. Time-series analysis of daily data from 3 stations in a small lake demon-tance the existence of strong beginned advection. strates the existence of strong horizontal advection within the basin at a time scale of 2-3 d and longer term periodicities (10-20 d) associated with the

#### Group 2H-Lakes

passage of atmospheric weather systems. Fluctuations in integral SRP concentrations at station 1 (outflow end) consistently occurred 3 d later than at station 3 (inflow end). The algal biomass (chlorophyll a) at station 1 lagged that at station 3 balf a day. The time lag between station 1 and station 3 for Aphanizomenon flos-aquae was 7 d, whereas for Ceratium hirundinella station 1 led station 3 by 3 d indicating motion by the species in opposite directions. The distribution of the algal biomass in space and time was a composite of the opposite directions. The distribution of the algal biomass in space and time was a composite of the individual species patterns. The periodicities in the average daily wind speed and water column stabili-ty were likely due to periods of vertical mixing. The use of chlorophyll as a measure of biomas hides much important information about the changing species composition of the assemblage. The characterization of these important mixing scales is a necessary preliminary step in under-standing the phytoplankton dynamics of the system. (Murphy-IVI) W84-03102

ROLE OF CURRENT ON THE DISTRIBUTION OF JUVENILE FISHES IN RESERVOIRS, Akademiya Nauk SSSR, Borok. Inst. Biologii Vnutrennykh Vod.

V. K. Konobeeva. Journal of Icthylogy, Vol. 23, No. 1, p 96-102, 1983. 2 Fig, 1 Tab, 21 Ref.

Descriptors: \*Fish, \*Reservoirs, \*Water currents,

Fish behavior, Rybinsk Reservoir, Ivan'kovo Reservoir, Velocity, Wind.

An attempt was made by labeling of the water masses and juvenile fishes and observations on their movement, to explain the role of current in the distribution of juvenile fishes in reservoirs using examples of Rybinsk and Ivan'kovo reservoirs. While many factors influenced the movement of young fish in the reservoirs, the water current was definitely the major one. Juvenile physophiloxy fishes that they interest of development of processing the processing the server of development on the server of the server of development on the server of th tophilous fishes at early stages of development can be carried by the current from the spawning ground into the open part of the reservoir. Larvae at development stages Al-E move in the open part of the lake and canal type reservoirs strictly with the watermass. In Rybinsk Reservoir (lake type), the fingerlings (standard length from 42-120 m) may drift not only passively in the water column but can also resist the current and move in a different direction over large distances irrespective of the velocity and direction of the current. In Tvan'kovo Reservoir which is of the canal type, not only the larvae but also advanced juveniles of 63-75 mm move with the watermass. This is probably due to high current velocity and its constant direction. (Baker-IVI) W84-03104

OOGENESIS OF THE RYBINSK RESERVOIR BREAM, ABRAMIS BRAMA (CYPRINIDAE), Akademiya Nauk SSSR, Borok. Inst. Biologii

Akademiya Nauk Vnutrennykh Vod.

A. M. Andreyéva. Journal of Icthyology, Vol. 23, No. 2, p 74-78, 1983. 2 Fig, 8 Ref.

Descriptors: \*Fish, \*Reservoirs, Rybinsk Reservoir, Bream, Temperature effects, Distribution, Population density

The annual sexual cycle of the bream, Abramis brama, of Rybinsk Reservoir and the duration of the individual stages of gonad maturity in specimens from different arms of the reservoir may be due to different temperature regimes. The bream is a major commercial species in the reservoir. The differences discovered in the annual sexual cycle of bream females from the Volga arm on the one hand and from the Mologa and North Sheksna arms on the other are further evidence of the arms on the other are further evidence of the existence in a single body of water such as Rybinsk Reservoir, of local bream populations previously found by tagging studies. Times and places of spawning, due to a different geographic position and hydrologic conditions of the body of water, are mainly responsible for the isolation of populations, although for a large part of the year individual fish groupings may also occupy common forag-

ing and possibly overwintering areas. (Murphy-IVI) W84-03105

THE INFLUENCE OF FLOW TURBULENCE

ON FISH BEHAVIOR, Akademiya Nauk SSSR, Moscow. Nauchnyi Sovet po Neorganischeskoi Khimii. L. G. Shtaf, D. S. Pavlov, M. A. Skorobogatov,

and A. Sh. Barekyan. Journal of Icthyology, Vol. 23, No. 2, p 129-140, 1983. 6 Fig, 7 Tab, 9 Ref.

Descriptors: \*Fish behavior, \*Turbulence, Fish, Streamflow, Velocity, Water currents

The flow of water, as the environment inhabited by fish, has a strong influence on their behavior. The fish select zones with a heightened degree of The fish select zones with a heightened degree of turbulence, on places of concentration, swimming capacity, compactness of schools of fish in currents with varying turbulence characteristics, and degree of orientation of fish at speeds close to threshold, depending on the flow movement regime. The duration of swimming of the roach depended on the degree of flow turbulence with the increase in the intensity of turbulence bringing about a decrease in turbulent flow. At speeds close about a decrease in turbulent flow. At speeds close to threshold, the degree of orientation of the fish depended on the conditions of flow movement. In turbulent flow the fish more readily orient in the direction of the velocity vector than in laminar flow. (Murphy-IVI) W84-03106

TOXICITY OF CYANOBACTERIA IN DUTCH LAKES AND RESERVOIRS,
Utrecht Rijksuniversiteit (Netherlands). Dept. of

Veterinary Pharmacology, Pharmacy and Toxicol-

Leeuwangh, F. I. Kappers, M. Dekker, and W. Aquatic Toxicology, Vol. 4, No. 1, p 63-72, August, 1983. 1 Fig, 5 Tab, 16 Ref.

escriptors: \*Toxicity, \*Cyanobacteria, \*Lakes, \*Reservoirs, Algal blooms, Scum, Hepatotoxins, Fast-death factor, Slow-death factor, Microcystis aeruginosa, Oscillatoria agardhii, Gloeotrichia

Poisoning of livestock, pet animals, waterfowl and fish by waterblooms or scums of freshwater cyanobacteria has been reported in literature from 1878 onwards. Since then there have been numerous cases of toxic waterblooms leading to a considerable loss of animals in many countries around the world. The waterblooms and scums of Microcystis aeruginosa, Oscillatoria agardhii and Gloetrichia echinulata showed that M. aeruginosa hepatotoxin(s) were present in 9 out of 10 locality of the control of tions. By i.p. injection in mice the cyanobacterial endotoxin(s), the so-called Fast-Death Factor (FDF) or microcystin caused death in mice within 3 hours. In most samples associated bacterial toxin(s), the so-called Slow-Death Factor (SDF) causing death within 4 to 48 h were possibly ed in SDF intoxication symptoms and mo tality. Suspensions of O. agardhii were also lethal. Syptoms and mortality can be attributed to at least two toxic factors. One resembling FDF, the other possibly resulting from associating bacteria. Ad-ministration of G. echinulata suspensions did not kill mice but produced symptoms of illness. The symptoms were not consistent with those of Mi-crocystis FDF or SDF. (Murphy-IVI) W84-03117

MACROBENTHIC FAUNA OF GREAT LAKE, ARTHURS LAKE AND LAKE SORELL, TAS-

Tasmania Univ., Hobart (Australia). Dept. of Zool-

Australian Journal of Marine and Freshwater Research, Vol. 34, No. 5, p 775-785, 1983. 2 Tab, 47

Descriptors: \*Benthic fauna, \*Great Lake, \*Arthurs Lake, \*Lake Sorell, \*Tasmania, Australia,

Population dynamics, Population density, Ecosystems, Lake fisheries, Fish establishment.

Tasmanian lakes have similar humbers of species to comparable systems overseas. It is best to know as much as possible about Tasmanian lakes in order to provide a basis for fisheries management. The benthic fauna as well as each lake's characteristics can provide insight into fisheries management. The benthic fauna of Great Lake, Arthurs Lake and Lake Sorell, Tasmania, contained 88 species, with 48-55 species in each lake. All three lakes had abundant and generally similar chironomid faunas. Arthurs Lake and Great Lake shared common oligochaete species of which only some were nu-merous in Lake Sorell. The crustacean faunas of mertous in Lake Sofen. In Crussaccan taulus of a each lake differed in composition and abundance, with amphipod species being the most abundant group in Arthurs Lake. Gastropod mollusks were the most abundant group in the fauna of Lake Sorell, and chironomids were most numerous in Great Lake. (Murphy-IVI) W84-03125

QUALITATIVE AND QUANTITATIVE VARIA-TION IN THE MACROBENTHIC FAUNA OF THE ORIGINAL LAKE AND NEW LAKE AREAS OF GREAT LAKE AND ARTHURS LAKE, TASMANIA, Tasmania Univ., Hobart (Australia). Dept. of Zool-

Australian Journal of Marine and Freshwater Research, Vol. 34, No. 5, p 787-803, 1983. 7 Fig, 6 Tab. 27 Ref.

Descriptors: \*Qualitative analysis, \*Quantitative analysis, \*Benthic fauna, \*Great Lake, \*Arthurs analysis, \*Benthic fauna, \*Great Lake, \*Lake, \*Tasmania, Australia, Lake morphology, Biomass, Water level fluctuations, Environmental

Faunal variation between sample sites in Great Lake and Arthurs Lake, using both qualitative and quantitative data could be useful in eventual fisher-ies management. Cluster analysis and principal co-ordinates analysis showed that the fauna of the original lake areas of both lakes is distinct from the fauna of the newly flooded areas. Closer relationships exist between the faunas of the old level of the two lakes than between the faunas of the old and new levels within either lake. The distinction is not attributable to depth but may be influenced by substrate differences. Abnormal fluctuations in water level may affect benthic populations in several ways. These include changes in water chemistry, elimination of macrophytes, alteration of substrates by erosion and exposure of substrates to air or ice cover. The sites at the old level were domi-nated by oligochaetes whereas chironomids contributed most to the sites at the new level. Consist-ent seasonal peaks were evident in the biomass at sites at the new level but not at sites at the old. The mean annual biomass levels (wet wt) for Great Lake (13.9 g/sq m) and Arthurs Lake (35.9 g/sq m) are comparatively above average values for other Australian and overseas lakes. (Murphy-IVI)

THE ALGAL COMMUNITIES OF THE UPPER BELGIAN MEUSE AND THE WATER QUAL-ITY: A SYNTHESIS AT FALL 1981 (LES COM-MUNAUTES ALGALES DE LA HAUTE MEUSE BELGE ET LA QUALITE DE SES EAUZ: UN BILAN A L'AUTOMENE 1981),

Liege Univ. (Belgium). Dept. of Botany

J.-P. Descy.
Bulletin de la Society Royale de Botanique de Belgique, Vol. 116, No. 1, p 31-50, 1983.

Descriptors: \*Meuse River, \*Belgium, \*Water quality, \*Algae, Diatoms, Chrysophyta, Chlorophyta, Cyanophyta, Biomass, Plankton, Benthos.

In samples taken in the Upper Belgian Meuse in the autumn of 1981, 126 taxa of microscopic algae were identified in the plankton. The chrysophytes (almost all diatoms) and chlorophytes comprized 62.7 and 30.2%, respectively. Quantitative analysis of samples taken from three sites shows the same

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trend, with a dominance of diatoms (60.6-64.7% of phytoplankton) and chlorophytes (27.9-34.0%). The remainder are almost all cyanophytes. There The remainder are almost all cyanophytes. There was a peak of biomass at the beginning of September, and a marked diminution at the beginning of Cotober. The microphytobenthos included 122 taxa of diatoms (samples were taken between 1976-1981 from three sites). The dominant diatoms are basophilic species of biotypes 4 and 5. The majority of the taxa are pollution-sensitive, demonstrating good water quality. (Moore-IVI) W84-03127

PRODUCTION AND DISTRIBUTION OF BENTHIC MICROALGAE IN THE LITTORAL SEDIMENTS OF MIKOLAJSKIE LAKE,

Rostock Univ. (German D.R.). N. Wasmund, and A. Kowalczewski. Ekologia Polska, Vol. 30, No. 3-4, p 287-301, 1982. 6 Fig. 2 Tab, 16 Ref.

Descriptors: \*Littoral environment, \*Algae, Benthic environment, Primary productivity, Lakes, Littoral zone, Mikolajskie Lake, Sediments.

Lake littoral is a specific environment characterized, among other things, by a great accumulation of algal biomass. For Mikolajskie Lake both chlorophyll and biomass in the top layers of sediments is related with the degree of site exposition to is related with the degree of site exposition to wave action, suggesting an easy transport of algae by waves to other sites of the littoral, or/and within the sediments. Vertical movements of benthic microalgae were noticed during the day. Photosynthetic activity of these algae was lower than that of other algal communities. Sampling techniques allowed the separation of sediment layers 1 cm thick down to the depth of 10 cm. Production was estimated in place for practically undisturbed samples. There is a distinguished vertical differentiation of the amount of chloroptical. undisturbed samples. There is a distinguished verti-cal differentiation of the amount of chlorophyll and biomass, especially at a site protected against the wave action. Diurnal vertical migrations of benthic microalgae were visible. The quick diminution of light within sediments limited the production of these algae to the upper few millimeters of sediments. Production of benthic microalgae seems to be better related with the amount of seems to be better related with the amount of chlorophyll than with biomass determined from cell volumes. Benthic microalgae may be the most important algal producer in shallow littoral com-munities. (Murphy-IVI) W84-03133

THERMAL CONDITIONS OF BOTTOM SEDI-MENTS IN FIVE SHALLOW LAKES OF MA-SURIAN LAKELAND,

Panstwowy Inst. Hydrologiczno-Meteorologiczny, Mikolajki (Poland). Regional Observatory.

S. Tyczynska. Ekologia Polska, Vol. 30, No. 3-4, p 303-325, 1982. 5 Fig, 3 Tab, 19 Ref.

Descriptors: \*Thermal stratification, \*Bottom sediments, \*Shallow lakes, \*Masurian Lakeland, Heat budget, Lake sediments, Thermal properties, Temperature gradient, Sediment-water interfaces, Poland.

Thermal conditions of bottom sediments to the depth of 4 m distinguish four thermal periods in a year. They are characterized by normal (June-August), reverse (December-March), spring and autumn (no homothermy). In the summer the epilimnion is the water and the thermocline and hypolimnion is in the sediments for all thermal zones in deep lakes. In the winter temperatures under the ice in the top layers of sediments increases in the shallowest lake (mean depth 0.6 m), whereas in other lakes the temperature decreases. The heat budget of sediments to total heat budget of the lake is reversely proportional to the depth of the lake and according to meteorological conditions is 28-42% in Gardynskie Lake (mean depth 2.4 m) and 56-70% in Lake Luknajno (mean depth 0.6 m). (Murphy-IVI) W84-03134

DISTRIBUTION OF FISH AND FOOD OF ROACH RUTILUS RUTILUS, BLEAK ALBUR-

NUS ALBURNUS BREAM ABRUMIS BRAMA AND RUFFE ACERINA CERNUA IN LAKE VANSJO, SOUTH-EAST NORWAY (FORDEL-ING AV FISK, SAMT ERNAERING HOS MORT, LAUE, BRASME OG HORK I VANSJO,

OSTFOLD), Oslo Univ. (Norway). Lab. for Freshwater Ecolo-gy and Inland Fisheries. A. Brabrand.

A. Diaurand. Fauna, Vol. 36, No. 2, p 57-64, 1983. 3 Fig, 3 Tab, 26 Ref.

Descriptors: \*Roach, \*Bleak, \*Bream, \*Ruffe, \*Fish food, \*Lake Vansjo, \*Norway, Fish diet, Fish behavior, Food habits, Aquatic habitats, Distribution patterns, Fish populations

Fish fauna distribution in different parts of the meso-/eutrophic lake Vansjo, SE Norway were dominated by roach, bleak, bream, white bream, dominated by roach, bleak, bream, white bream, perch and ruffe in the shallow parts of the lake, while roach and bleak were also pelagically at night, in the upper water masses. In the littoral, roach had a variable diet including cladocerans, insect larvae and vegetation, while cladocerans were by far the most dominating food item for bleak. Pelagically both fed on cladocerans. Bleak size selected Bosmina and Daphnia. Bream and ruffe were both bottom feeders. Ruffe selected much more for animal food compared to the bream, which had a high proportion of sediments in their guts. (Murphy-IVI)

THE ECOLOGY OF LAKE NAKURU (KENYA); IV. BIOMASS AND DISTRIBUTION OF CONSUMER ORGANISMS,

Munich Univ. (Germany, F.R.). Zoologisches Inst. E. Vareschi, and A. Vareschi. Oecologia, Vol. 60, No. 1, p 70-82, 1984. 13 Fig, 6 Tab, 50 Ref. German Science Foundation grants Ja 145/5 and 145/7.

Descriptors: \*Ecology, \*Lake Nakuru, \*Kenya, \*Biomass, Aquatic productivity, Consumer organisms, Saline lakes, Alkaline water, Ecosystems, Ecological distribution

Consumer biomass and spatial distribution data provide the basis for estimating feeding and pro-duction rates, and for quantifying energy flow at the consumer level for the equitorial alkaline-saline the consumer level for the equitorial alkaline-saline Lake Nakuru. An outstanding characteristic of the lake is its biological simplicity. In order to estimate temporal biomass changes of all lake organisms, samples were taken at 19 stations at monthly intervals. The biomass of the only planktonic crustacean, the copepod Lovenuia africana was very high (1.5 g dry weight/cu m) in 1972 and 1973. Lovenula was absent in 1974 and 1975, and at very low levels in part of 1976. For short periods rotifers can be the dominant species of Lake Nakuru. During high salinity periods (greater than 20%) Hexarthra jenkinae occurred in very low numbers. Hexarthra jenkinae occurred in very low numbers. Aquatic heteroptera (four species) contributed 0.4% to total consumer biomass in 1972 and 1973. 0.4% to total consumer biomass in 1972 and 1973. In 1974-1976 the lake had no aquatic heteroptera. Benthic biomass (0.4 g dry weight/sq m) consisted almost exclusively of Leptochironomus deribae. For birds, Pelecanus onocrotalus accounts for approximately 90% of the biomass with peak densities of almost 20,000 birds. (Murphy-IVI)

THE ECOLOGY OF LAKE NAKURU (KENYA); V. PRODUCTION AND CONSUMPTION OF CONSUMER ORGANISMS,

Munich Univ. (Germany, F.R.). Zoologisches Inst. E. Vareschi, and J. Jacobs. Oecologia, Vol. 61, No. 1, p 83-98, 1984. 7 Fig, 13 Tab, 77 Ref. German Science Foundation grants Ja 145/5 and Ja 145/7.

Descriptors: \*Lake Nakuru, \*Kenya, \*Production, \*Consumption, \*Consumer organisms, Energy balance, Rotifers, Copepods, Chironomids, Fish, Birds, Biomass, Water fowl.

Production and consumption rates were estimated from the distribution of numbers and size classes in the lake and laboratory experiments on growth and filtration rates. Data from consumer production and consumption in Lake Nakuru from 1972 to 1976, provide the basis for estimating the major pathways of energy flow. Rotifers (Brachionus dimidiatus and B. plicatilis), not especially significant in biomass, had the highest production rates. Consumption rates were correspondingly high. Copepods almost matched rotifers in 1972/73 but vanished from the lake in the following years. Chironomid larvae and fish had similar ranges of production and consumption. The fish had about Chironomid larvae and fish had similar ranges of production and consumption. The fish had about twice the biomass of the insects. Most primary consumer organisms fed on the dominant primary producer, the cyanophyte Spirulina platensis, but rotifers and Leptochironomus met an unknown fraction of their energy requirements by consuming bacteria and detritus. The total fish yield taken by birds was 2,700-9,500 metric tons (wet weight) per year. (Murphy-IVI) W84-03150

A QUANTITATIVE STUDY OF PHYTOPLANK-TON OF THE RIVER GANGES AT BHAGAL-PUR, INDIA, Bhagalpur Univ. (India). Post-Graduate Dept. of Botany and Zoology. N. K. Singh, J. S. D. Munshi, and K. S. Bilgram.

Polskie Archiwum Hydrobiologii, Vol. 30, No. 2, p 81-87, 1983. 1 Fig, 2 Tab, 32 Ref.

Descriptors: \*Phytoplankton, \*Ganges River, \*Bhagalpur, \*India, Phosphorus, Nitrogen, Silicates, Chlorides, Temperature effects, Thermal stress, Benthos, Biomass.

Samples of Ganges River surface water were collected at monthly intervals from January, 1978 to December, 1978 using a water sampler. The maxinum phytoplankton standing stock was in the summer with the highest peak in May when the water temperature was between 26 to 35 C. There was a sharp fall in standing stock when turbidity was very high. Free carbon dioxide was absent was very high. Free caroni unities was assert during active growth of phytoplankton (January to May) due to its utilization in photosynthesis. The pH rose during this period. The silicate level was considerably reduced when the standing stock of diatoms was maximum. Phosphorus and total nitro-gen of water expressed inverse correlation to phytoplankton standing crop. Phosphorus, silicate and total nitrogen levels were higher during the rains while the chloride concentration rose during the summer. (Murphy-IVI) W84-03151

ECOLOGY OF PLANKTONIC LARVAE OF DREISSENA POLYMORPHA (PALL.) IN LAKES WITH DIFFERENT DEGREE OF HEATING,

Polish Academy of Sciences, Krakow. Zaklad Biologii Wod. For primary bibliographic entry see Field 5C. W84-03152

MIXING PROCESSES IN LAKES: MECHANISMS AND ECOLOGICAL RELEVANCE,

Eidgenoessische Anstalt fuer Wasserversorgung Abwasserreinigung und Gewaesserschultz, Due bendorf (Switzerland).

D. M. Imboden, U. Lemmin, T. Joller, and M. Schurter.

Schweierische Zeitschrift fur Hydrologie, Vol. 45, No. 1, p 11-44, October, 1983. 21 Fig, 4 Tab, 38

Descriptors: \*Mixing, \*Hypolimnion, \*Lake Baldegg, \*Switzerland, Tracers, Radon, Tritium, Helium radioisotopes, Water circulation, Kinetic energy, Wind, Heat exchange, Stratification, Internal waves, Energy transfer, Density gradients.

In Lake Baldegg, Switzerland (surface area 5.3 sq In Lake Baldegg, Switzeriand (surface airae 3.5 sq km, maximum depth 66 m) the analysis of data from moored instrument systems (atmospheric boundary layer, lake temperature distribution, bottom currents) was correlated to the long-term development of vertical mixing as seen from pro-files of natural isotopes (radon-222, tritium and helium-3) and chemical species. Since the input of

#### **Group 2H—Lakes**

kinetic energy by inlets is small, mixing in the lake is mainly driven by wind and heat exchange at the surface. During most of the year, thermally and chemically induced density stratification prevents the energy input from penetrating into greater depths. Part of the energy is trapped in internal waves running along the thermocline with little damping. Mixing in the surface layer is highly transient in nature. Strong temperature gradients develop in the surface layer on warm, calm days. Internal waves dominate the internal dynamics during stratification. Internal waves seem to be an important mechanism for kinetic energy transfer to the hypolimnion. The coherence between internal seiching and periodicities in the bottom currents een internal supports this point. The indirect nature of energy transfer makes hypolimnion mixing less sensitive to transier makes hypoliminon mixing less sensitive to meteorological forcing as long as stratification is well-developed and winds are not too strong. When vertical density gradients become weak, direct coupling between wind forces and mixing at all depths is observed. Internal loading is very significant in Lake Baldegg. Water ages, traced by helium and tritium, question the idea that as far as vertical mixing goes, stagnation and circulation are two well-distinguishable states of the lake. Renewal of deep hypolimnic water is significant even during stratification. (Moore-IVI) W84-03167

CHEMICAL AND GEOCHEMICAL STUDIES OF LAKE BIEL; II. A CHEMICAL APPROACH TO LAKE MIXING,

Bern Univ. (Switzerland). Dept. of Inorganic

U. P. Uyffeler, P. W. Schindler, U. E. Wirz, and

D. M. Imboden. Schweizerische Zeitschrift für Hydriologie, Vol. 45, No. 1, p 45-61, October, 1983. 12 Fig. 2 Tab. 24

Descriptors: \*Lake Biel, \*Switzerland, \*Mixing, \*Eddy diffusion, Water temperature, Radon, Tra-ers, Water circulation, Chemical properties.

The mixing parameters in Lake Biel (Switzerland) are established in terms of coefficients of eddy diffusion in a two-dimensional box model. The vertical eddy diffusion coefficients were determined as a function of depth and time using the temperature method. Simultaneously with the temperature, the vertical excess Rn-222 concentration (\*Rn-222) was measured. For observed transient Rn-222 distribution, transport by advection was included in the model calculations. A reasonable modelling of photosynthesis requires vertical sub-division of the epilimnion. Simultaneous measurements along one profile of two tracers that differ in the directions of their propagation give access to both vertical and horizontal lake mixing. The special suitability of Rn-222 is based on its short half-life time that produced high concentration gradients and permited recording short time phenomena. This method is restricted to comparatively small basins and to lake systems with Ra-226 bearing sediments. The eddy diffusion coefficients give an appropriate description of the observed distribuan appropriate description of the conserved distribu-tion of both temperature and \*Rn-222, but have limited physical significance as they are operation-ally defined in terms of an arbitary model. (Murphy-IVI) W84-03168

HYDRODYNAMICS OF THE LAKE OF GENEVA,

Ecole Polytechi ique Federale de Lausanne (Switzerland). Lab. d'Hydraulique. W. H. Graf.

Schweizerische Zeitschrift fur Hydrologie, Vol. 45, No. 1, p 62-100, October, 1983. 28 Fig, 3 Tab, 21 Ref.

Descriptors: \*Hydrodynamics, \*Lake Geneva, \*Lake Leman, \*Switzerland, Orography, Hydrologic models, Model studies, Wind waves, Water circulation, Mathematical models, Air-water inter-Wind-driven currents, Mixing, Seiches,

In a certain sense, Lake Leman is an artifical lake since it is regulated hydraulically at Geneva (Swit-

zerland). Extensive meteorological information. coupled with atmospheric dynamics over the lake helped develop working mathematical models. Air stability plays an important role for weak winds. Medium and strong winds are near neutral. Wind driven movement and wind generated surface waves are the types of lake motion which countries to the movement and wind generated surface waves are the types of lake motion which countries to the movement (and mixing) in lake 1 movement. utes to the movement (and mixing) in lake Leman and as to what types of wave climates exist. The movement in lakes is mathematically represented movement in makes is mathematically represented with a set of equations, namely the equations of continuity, of momentum, of heat conduction, of diffusion of matter and of state. For an incompressible, homogeneous and shallow lake, where the tone, nonlogeneous and stantow make, where the horizontal mixing is negligible compared with vertical mixing, the linearized system of equations are integrated. The steady-state circulation model and the storm surge and seiche models also use integrated mathematical models. (Murphy-IVI) W34-03169

HYDRODYNAMIC STUDIES OF LAKE ZURICH AND LAKE LUGANO; A COMPARI-SON BETWEEN FIELD MEASUREMENTS AND RESULTS OF THEORETICAL MODELS, (STROMUNGSDYNAMISCHE UNTERSU-(STROMUNGSDTNAMISCHE UNTERSU-CHUNGEN IM ZURICH- UND IM LUGANER-SEE; EIN VERGLEICH VON FELDMESSUN-GEN MIT RESULTATEN THEORETISCHER

Eidgenoessische Technische Hochschule, Zurich (Switzerland). Versuchsanstalt fuer Wasserbau, (Switzerland). Versuchsanstalt Hydrologie und Glaziologie. Wasserbau,

Hutter

Schweizerische Zeitschrift fur Hydrologie, Vol. 45, No. 1, p 101-144, October, 1983. 26 Fig, 3 Tab,

escriptors: \*Hydrodynamics, ake Lugano, \*Switzerland, \*Lake Zurich, \*Mathematical \*Value Lugano, \*Switzerland, \*Mathematical models, \*Water currents, Wind-driven currents, Hypolimnion, Isotherms, Seiches, Model studies, Density, Water temperature.

Density distribution and temperature and current Density distribution and temperature and current data measured in Lake Zurich and Lake Lugano during two summer field programs are interpreted by means of hydrodynamic models. With the exception of the hypolimnion current the employed set of instruments was suitable to reliably measure the 'lake relevant' physical quantities. Comparisons of the time series of the isotherm depths permits correlation of the observed wind induced oscilla-tions with the internal seiches behavior. Time tions with the internal seiches behavior. Time series of limingraphs mounted along the shores permit identification of the periodic barotropic components of the motion. By applying the shallow water equations to Lake Zurich, the periods and the structures of (even high) surface seiches are reliably predicted. For satisfactory prediction of wind-induced barotropic motions of Lake Zurich a three-dimensional circulation model is used. The applicacy adjusting the propriets and the structure that the series were the inused. The nonlinear advective terms must be in-cluded in this analysis. Internal seiches are treated with a linear two-layer model, and periods and structures of the eigenmodes are well predicted with it. Baroclinic wind-induced motions are modelled by a three-dimensional FD-Model which tested using a real, measured wind field. The motion, which is directly influenced by the wind is reliably predicted. The oscillations in the numerical model after the wind cessation are too attenuated. (Murphy-IVI) W84-03170

NUMERICAL MODELS FOR THE CURRENTS SIMULATION OF A LAKE (MATHEMATISCHE MODELLE ZUR SIMULATION VON ZIRKULATIONSSTROMUNGEN SEE).

Laboratorio di Fisica Terrestre, Lugano-Trevano (Switzerland) D. Bozzolo, R. Pamini, G. Salvade, F. Solca, and

C. Spinedi. Schweizerische Zeitschrift fur Hydrologie, Vol. 45, No. 1, p 145-175, 1983. 30 Fig, 13 Ref.

Descriptors: \*Mathematical models, \*Computer models, \*Lakes, \*Water currents, Simulation, Wind-driven currents, Thermodynamics, Mixing, Thermal pollution, Water circulation, Lake Lugano.

The three-dimensional, finite-difference model of the physical processes in a lake has been adapted to the simulation of wind-induced currents and ther-mal processes in the northern basin of Lake Lugano. The advantages of the model are the use of complete hydrodynamic and thermodynamic equations, with only the Boussinesq approximation and the modelling of eddy viscosity through a dynamic algorithm. The model can simulate windinduced currents in a stratified lake, including all thermal interactions and inflows. Because of the size of the computer program, the model takes long computation times in a large core computer. The model includes all thermal interactions with The model includes an internations with the atmosphere, wind-induced mixing processes, inflows and outflows. The model predictions are compared with data collected in 1979. A further application of the model is the cold inflow simulaapprication of the floods is the cold immoves influent tion in a stratified basin with inclusion of turbulent vertical exchange processes. A two-dimensional version of the model, which assumes an hydrostatic presssure distribution, is utilized to simulate the thermal summer development of Lake Lugano, during 40 days. The model includes the thermal interactions and wind influence. The three-dimensional model can be applied to current simulation in lake basins. The two-dimensional model may be utilized to predict the development of a basin subject to a thermal load. (Moore-IVI) W84-03171

UPTAKE, TRANSLOCATION AND RELEASE OF CARBON BY SUBMERSED MACRO-PHYTES FROM RUNNING WATER HABI-TATS (AUFNAHME, TRANSPORT UND ABGABE VON KOHLENSTOFF DURCH SUB-MERSE MAKROPHYTEN VON FLIESSWAS-SERSTANDORTEN,

Bayerisches Landesamt fuer Wasserwirtschaft, Munich (Germany, F.R.).

V. C. Steinberg, and A. Melzer.
Schweizerische Zeitschrift für Hydrologie, 45, No. 1, p 333-343, October, 1983. 3 Fig, 21 Ref.

Descriptors: \*Submerged plants, \*Running waters, \*Carbon, Hardness, Plant metabolism, Roots, Foliage, Uptake, Translocation.

Uptake, translocation and release of inorganic carbon were tested in partitioned chambers with submersed running water macrophytes from hard-water habitats (Potamogeton coloratus, Ranunculus fluitans, R. circinatus, Myriophyllum spicatum, Callitriche obtusangula and Berula erecta) and R. fluitans from a soft-water habitat. All species were able to remove labelled inorganic carbon from the water by both systems, foliage and rhizome/root system, the uptake via foliage predominating clearly. Most of the carbon taken up by the rhizome/root system was translocated into the phytosyntheroot system was translocated into the phytosynthe-tically active tissues, most likely as an inorganic species of carbon dioxide. The reversed transloca-tion was rather small with most of the species, probably due to short exposure times. Release of labelled carbon was below 1% of total uptake, except for C. obtusangula and R. fluitans from the soft-water habitat. The low carbon release is a reasonable adaptation to the constantly renewing milieu in running-water habitats. (Moore-IVI) W84-03175 W84-03175

OXYGEN REGIME IN A FISHPOND WITH DUCKWEEDS (LEMNACEAE) AND CERATO-PHYLLUM,

Ceskoslovenska Akademie Ved, Trebon. Dept. of Hydrobotany.

J. Pokorny, and E. Rejmankova. Aquatic Botany, Vol. 17, No. 2, p 125-137, October, 1983. 3 Fig, 4 Tab, 21 Ref.

Descriptors: \*Duckweed, \*Ponds, \*Oxygen balance, Fish, Phytoplankton, Vegetation, Lemnaceae, Ceratophyllum, Nutrients,.

In small fishponds, usually highly eutrophic, com-munities of Ceratophylletum demersi with a cover of duckweeds occurs. Through their relatively high biomass this vegetation influences the gas regime in the fishponds. The depth of oxygen and the daily changes in oxygen concentration were

assessed by in situ measurements in stands of Lem-naceae, Ceratophyllum, Lemnaceae plus Cerato-phyllum, and phytoplankton at the peak of the vegetation season. With the aim of excluding the influence of phytoplankton on the diurnal oxygen course, oxygen concentrations were measured in near natural conditions below both the dense and the loose covers of Lemnaceae, placed in nutrient solution. The duckweeds Lemna minor and Spirosolution. The duckweeds Lemna minor and spiro-dela polyrhiza did not release any oxygen into the water on which they were floating. The frequently occurring combination of submerged Ceratophyl-lum with floating ducksweeds improves the oxygen concentration in the fish ond water as oxygen concentration in the fishpond water as compared with water covered only by duckweeds. Oxygen is transported from the upper aerated water layers to the bottom of the shallow pond. The average oxygen concentration was up to 2 mg/liter lower when sediments were present, and the flow of oxygen to the bottom amounted to 4 g/sq m/day. (Baker-IVI)

IMPACT OF ACIDIFICATION AND EUTRO-PHICATION ON MACROPHYTE COMMUNI-TIES IN SOFT WATERS IN THE NETHER-LANDS, I. FIELD OBSERVATIONS,

Katholieke Univ., Nijmegen (Netherlands). Lab. of Aquatic Ecology. J. G. M. Roelofs.

Aquatic Botany, Vol. 17, No. 2, p 139-155, October, 1983. 1 Fig, 6 Tab, 41 Ref.

Descriptors: \*Eutrophication, \*Acidification, Macrophytes, Netherlands, Littoral environment, Aquatic life, Light intensity.

Aquatic habitats appear to be very susceptible to the effects of acidification. The mechanisms of acidification, however, appear to be very complex and are not yet clearly understood. A strong de-cline has been noticed in the number of waters dominated by Littorellion species during the last decades. These have been mainly isoetids such as Lobelia dortmanna L., Isoetes lacustris L., and Littorella uniflora (L.) Aschers. Investigations were carried out at 68 locations where the waters were carried out at 68 locations where the waters were known to be dominated by L. uniflora after 1950. In 1980, L. uniflora appeared to be absent or to have strongly decreased in 53 (78%) of these waters. In 41 of them, Littorella had been replaced by submerged Juncus bulbosus L. and/or Sphagnum spp. Changed inorganic carbon budgets appear to be responsible for the changes resulting as an effect of acidification. Eutrophication of the water and/or sediment in the remaining 12 waters. water and/or sediment in the remaining 12 water sources seems to be responsible for the changes in the plant communities. Enrichment with phosphate of the mineral sediment alone led to luxurious the plant communities. Enrichment with phosphate of the mineral sediment alone led to luxurious growth of submerged, rooted macrophyte species such as Myriophyllum alterniflorus DC and Ranuculus peltatus Schrank. Phosphate-enrichment of both sediment and water led to luxurious growth of pleustophytes such as Riccia fluitans L. and Lemna minor L. in small, shallow waters and to plankton bloom and growth of epiphytes in larger, deeper waters. Light limitations seem responsible for the disappearance or decline of the Littorellion species. (Baker-IVI) W84-03196

CARBONATE MINERALOGY OF LAKE SEDI-MENTS AND SURROUNDING SOILS. 2. THE QU'APELLE LAKES, Saskatchewan Univ., Saskatoon. Dept. of Soil Sci-

ence. K. Ghebre-Egziabhier, and R. J. St. Arnaud. Canadian Journal of Soil Science, Vol. 63, No. 2, p 259-269, May, 1983. 5 Fig, 3 Tab, 13 Ref. NSERC Grant No. A1446.

Descriptors: \*Lake sediments, \*Carbonates, Mineralogy, Lakes, Sediments, Qu'Appelle Lake, Magnesium, Dolomite, Erosion.

The nature and distribution of carbonate minerals in the upper Qu'Appelle basin in south-central Saskatchewan were investigated. Erosional effects appear to have resulted in sediments which were derived largely from neighboring landscapes. Of particular importance is the build-up of carbonates

in these sediments in situations where the water chemistry of the lake waters favors precipitation of calcium carbonate. Waters in the Fishing Lakes calcium carbonate. Waters in the Fishing Lakes (Pasqua, Echo, Katepwa) contain appreciably more soluble salts than Buffalo Pound Lake upstream from them. The increased CaCO3 contents of the sediments in going from the Buffalo Pound to the Pasqua, and Echo Lakes coincide with the increased ionic concentrations of calcium and carbonate ions, as reflected by increasing ionic activity products. This parallelism plus the presence of Mg-bearing calcites supports the evidence indicating that carbonates are being precipitated in the lakes. (Baker-IVT)

THE MACROINVERTEBRATE FAUNA OF THE DRAINAGE CHANNELS OF THE GWENT

LEVELS, SOUTH WALES, University of Wales Inst. of Science and Technology, Cardiff. Dept. of Applied Biology. For primary bibliographic entry see Field 5C. W84-03289

THE IMPACT OF ZOOPLANKTON FEEDING ON THE EPILIMNETIC BACTERIA OF A EU-TROPHIC LAKE

Wisconsin Univ.-Madison. Dept. of Bacteriology. C. Pedros-Alio, and T. D. Brock. Freshwater Biology, Vol. 13, No. 3, p 227-239, June, 1983. 4 Fig. 4 Tab, 43 Ref. NSF grant DEB-

Descriptors: \*Zooplakton, \*Feeding rates, \*Epilimnion, \*Bacteria, \*Eutrophic lakes, Ecological effects, Biomass, Lake Mendota, Population dy-

In order to elucidate the importance of zooplankton feeding on bacteria in Lake Mendota, biomass
and production of heterotrophic bacteria have
been measured over a 2 year period and while the
biomass was fairly constant from year to year,
production was very high from June to October.
Feeding of zooplankton on bacteria was measured
by a cell counts method in 1979 and using radioactively labelled natural assembleges of bacteria in
1980. Total feeding was calculated and was found
to account for 1-60% of the bacterial heterotrophic
production. Annually, it accounted for 1-10% of
the bacterial heterotrophic production. Since bacterial biomass does not change significantly from
year to year and yet bacterial production is very
high compared to feeding by zooplankton, mechamisms other than feeding must exist which remove
biomass from the epilimnetic bacteria in larger
amounts. (Murphy-IVI)
W84-03290 W84-03290

THE EFFECTS OF SURFACE GEOLOGY AND STREAM SIZE ON FRESHWATER MUSSEL (BIVALVIA, UNIONIDAE) DISTRIBUTION IN SOUTHEASTERN MICHIGAN, U.S.A., Cornell Univ., Ithaca, NY. Section of Ecology and

Systematics.

D. Strayer.

Freshwater Biology, Vol. 13, No. 3, p 253-264,

June, 1983. 8 Fig, 2 Tab, 42 Ref.

Descriptors: \*Mussels, \*Habitats, Michigan, Mollusks, Turbidity, Streams, Catchment areas, Aquatic habitats.

Stream size and surface geology are the two major environmental features controlling the distribution of the 34 species of unionid mussels living in streams in southeastern Michigan. Surface geology, a previously unrecognized factor in the ecology of freshwater mussels, regulates the hydrology, slope and turbidity of streams in this area. Reciprocal averaging ordinations are used to aid the description of the habitats occupied by each mussel species. Thus the theory that the catchment of a species. Thus the theory that the catchment of a stream is partially responsible for the biota of that stream has been verified. In general, conditions at any site along a stream are defined both by constraints that are imposed on all running waters such as hydraulic geometry and by the catchment of that particular stream. (Baker-IVI) W84-03291

THE PHYSICAL LIMNOLOGY OF AUGHER LOUGH (NORTHERN IRELAND),

New Univ. of Ulster, Coleraine (Northern Ireland). Limnology Lab. B. Ripley.

Freshwater Biology, Vol. 13, No. 4, p 353-362, August, 1983. 7 Fig. 3 Tab, 33 Ref.

Descriptors: \*Limnology, \*Augher Lough, \*Ireland, Thermal stratification, Hypolimnion, Oxygen deficit, Thermocline, Epilimnion, Hypolimnion, Eddy diffusion, Heat budget.

The physical limnology of Augher Lough, Northern Ireland (area = 9.25 ha, mean depth = 5.5 m), including stratification pattern, heat budget, thermocline erosion rate, eddy diffusion rate in the thermocline and hypolimnion and areal hypolimneic oxygen deficit provides a suitable background for an examination of the recent sedimentary record. The aim is to present a description of the physical limnology of Augher Lough and to compare this with the behavior expected from the relationships of physical limnology. Oxygen and relationships of physical limnology. Oxygen and temperature profiles, at two sites during 1978 and four sites during 1979, showed that spatial variabilities ity of these quantities was low and allowed the following lake characteristics to be estimated. Heat following lake characteristics to be estimated. Heat budget was 5.30 kcal/9q cm (standard deviation = s = 0.26) in 1978 and 5.00 (s = 0.26) in 1979. The thermocline depth was 3.5-6.5 m with an erosion rate of 1.9 x .00001 m/s in 1979. Eddy diffusion coefficients of heat in the thermocline and hypolimnion normally ranged from 0.48 x 0.1 sq cm/s (s = 0.20 x 0.1) to 5.4 x 0.1 (s = 2.6 x 0.1), but reached 10 x 0.1 sq cm/s (s = 9 x 0.1) in early July 1978 after a cooling-main generated in the entition. reached 10 x 0.1 sq cm/s (s = 9 x 0.1) in early July 1978 after a cooling-mixing episode in the epilimnion. The hypolimnetic oxygen deficit was 680 mg O2/sq m/d (s = 76) and varied strongly with depth. A cooling-mixing episode in the epilimnion in June-July 1978 caused the movement of heat down to 8 m, movement of oxygen down to 6 m and increased the eddy diffusion coefficients of heat by an order of practitude. Murphy JULY heat by an order of magnitude. (Murphy-IVI) W84-03294

MICROBIAL HETEROTROPHIC UTILIZA-TION OF DISSOLVED ORGANIC MATTER IN A PIEDMONT STREAM,

Academy of Natural Sciences of Philadelphia, Avondale, PA. Stroud Water Research Center. For primary bibliographic entry see Field 5B. W84-03295

BIOMASS AND PRODUCTION OF PHYTO-AND BACTERIO-PLANKTON IN EUTROPHIC LAKE TYSTRUP, DENMARK,

Copenhagen Univ., Hilleroed (Denmark). Det Ferskvands-Biologiske Lab. B. Riemann

Freshwater Biology, Vol. 13, No. 4, p 389-398, August, 1983. 4 Fig, 3 Tab, 37 Ref.

Descriptors: \*Biomass, \*Phytoplankton, \*Bacterio-plankton, \*Eutrophic lakes, \*Lake Tystrup, \*Den-mark, Primary productivity, Organic matter, Bac-

The phytoplankton in eutrophic lakes plays a dominant role in the production of organic matter. Decomposition and mineralization of the organic Decomposition and mineralization of the organic matter are mainly bacterial processes. Phytoplankton primary production and biomass were compared with bacterial secondary production estimated by means of frequency of dividing cells (FDC) in eutrophic Lake Tystrup, Denmark. In the upper part of the photic zone, bacterial secondary production constituted 12% of the carbon fixed by the phytoplankton. In vertical profiles, bacterial secondary production ranged from 7.6% (early spring) to 121% (during August) of the carbon fixed by the algae. A close relationship was found between occurrence and activity of bacteria, and algae, suggesting that released organic products algae, suggesting that released organic products are of primary importance to the bacteria. The annual phytoplankton primary production was estimated as 227 g C/sq m compared to 102 g C/sq m assimilated by the bacteria, so 45% of the carbon

#### Group 2H-Lakes

fixed by the photoplankton went through pelagic bacteria. (Murphy-IVI)

PRIMARY PRODUCTIVITY STUDIES DURING EARLY YEARS OF WEST POINT RESERVOIR, ALABAMA-GEORGIA,

Auburn Univ., AL. Dept. of Fisheries and Allied Aquacultures. For primary bibliographic entry see Field 5C.

COMMUNITY STRUCTURE IN SOME SOUTHERN ENGLISH STREAMS: THE IN-FLUENCE OF PHYSICOCHEMICAL FAC-

University of East Anglia, Norwich (England). School of Biological Sciences. For primary bibliographic entry see Field 5C. W84-03300

THE COLONIZATION OF BALL-CLAY PONDS BY MACROINVERTEBRATES AND MACROPHYTES,

Exeter Univ. (England). Inst. of Biometry and Community Medicine.

L. E. Barnes.

Freshwater Biology, Vol. 13, No. 6, p 561-578, December, 1983. 8 Fig, 3 Tab, 37 Ref.

Descriptors: \*Community development, \*Ponds, \*Macroinvertebrates, \*Macrophytes, Population dynamics, Population density, Hydrogen ion concentration. Principal component analysis

To provide information of practical application in the management of new ball-clay ponds in the present study, it was necessary to investigate colonization over a much longer time-span and to include both macrophytes and macroinvertebrates. The rate and nature of colonization of ball-clay ponds by aquatic macrophytes and macroinverte-brates were studied by comparing communities present in a series of ten ponds of similar dimensions, but of different ages, ranging from 6 months to 15 years. Multivariate analyses of the biotic data distinguished between 'neutral' and 'acid' ponds; further analyses concentrated on the former ty Initial colonization of neutral ponds was rapid w a predictable sequence of species arrival, probably reflecting short dispersal distances. Variations in macroinvertebrate invasion times were related to dispersal strategy and ability. As the pond aged, successional changes, linked with macrophyte col-onization, produced a shift in dominance from algivores and predators towards epiphyton grazers and detritivores. Some evidence of succession of species within invertebrate orders was found. Low pH affected colonization principally by preventing the establishment of acid-intolerant immigrant species, but also by retarding succession. It is conclud-ed that non-interactive models of insular colonization, with constant immigration and extinction rates, are of limited applicability to pond colonization in temperate areas. (Murphy-IVI)

DIATOMS IN FOUNTAINS, RESERVOIRS AND SOME OTHER HUMID AND DRY LO-CALITIES IN ROME, ITALY,

N. Foged. Nova Hedwigia, Vol. 38, p 433-455, 1983. 1 Tab,

Descriptors: \*Diatoms, \*Fountains, \*Reservoirs, \*Rome, \*Italy, Hydrogen ion concentration.

antains, reservoirs, waste-pipes and other more Fountains, reservoirs, waste-pipes and other more or less moist localities in towns are often biotopes with a character of their own and generally fairly rich. The analyzed coatent from 21 samples collected in 1951 from 17 localities in Rome, Italy (fountains, reservoirs and other humid and dry localities), revealed 135 taxs of diatoms from 31 genera. The water, which in 1951 chiefly came from the surrounding country through aqueducts, was more or less alkaline. (Murphy-IVI) W84-03311 LIFE HISTORY AND ECOLOGY OF THE HUMPBACK CHUB IN THE LITTLE COLORADO AND COLORADO RIVERS OF THE GRAND CANYON,

Fish and Wildlife Service, Flagstaff, AR. Colorado River Fishery Project.

L. R. Kaeding, and M. A. Zimmerman.

Transactions of the American Fisheries Society,
Vol. 112, No. 5, p 577-594, September, 1983. 11
Fig. 5 Tab, 21 Ref.

Descriptors: \*Fish, \*Rivers, Colorado River, Little Colorado River, Grand Canyon, Seasonal vari-ations, Littoral environment, Darkness, Light in-tensity, Habitats, Aquatic habitats, Fish behavior,

The loss of habitat for some native fishes of the The loss of habitat for some native fishes of the Colorado River drainage coincided with the closure of Flaming Gorge Dam on the Green River. Humpback chubs in the Little Colorado River grew rapidly to about 250-300 mm in length at 3 yr of age, the onset of reproductive maturity for the female. Annual reproductive success was greatest when spawning coincided with seasonal river runoff. Use of the physical habitat by age-0 and juvenile humpback chubs was affected by light intensity. Shallow littoral areas were used during darkness, but during daylight only when the water was turbid. Year-round low temperatures in the Colorado River did not inhibit seasonal gonadal maturation of humpback chubs. However, lab studies indicate that such low temperatures result studies indicate that such low temperatures result in nearly complete mortality of embryonic and larval humpback chubs. Persistence of the fish in the Little Colorado River could be attributable, in part, to the unsuitability of that environment, and that of the Colorado River, for potential competi-tor or predator species in the drainage. (Baker-IVI) W84-03318

MORTALITY OF WALLEYE EGGS AND RAIN-BOW TROUT YOLK-SAC LARVAE IN LOW-PH WATERS OF THE LACLOCHE MOUN-TAIN AREA, ONTARIO,

Trent Univ., Peterborough (Ontario). Dept. of Bi-

P. F. Hulsman, P. M. Powles, and J. M. Gunn Transactions of the American Fisheries Society, Vol. 112, No. 5, p 680-688, September, 1983. 5 Fig,

Descriptors: "Mortality, "Walleye, "Trout, "Larvae, "Acid waters, "LaCloche mountains, Ontario, Streams, George Lake, Hydrogen ion concentration, Acidity, Acidic water, Toxicity.

Freshly fertilized eggs of walleye Stizostedion vi-Freshly fertilized eggs of walleye Stizostedion virteum were incubated in the outlet waters of George Lake (pH 5.4) and sections of a nearby stream (pH 6.0, 6.6). Walleye egg mortality was low (25.5-33.5%) at pH 6.0. High mortality (90.5%) occurred between fertilization and the eyed-egg stage at the pH 5.4 site. Mortality of rainbow trout yolk-sac larvae approached 100% within 5 days at both pH 4.6 and 5.4. In contrast, total mortality was less than 3% at pH 6.0 and also in low-pH humic water (pH 5.5). The high mortality rate in the acidic outlet waters of George Lake suggests that the acidification of this lake was responsible for the extinction of its walleye stock. The striking differences in mortality of rainbow trout yolk-sac larvae between sites of similar pH trout your-sac narvae between sites of similar prin (5.4-5.5) indicated that H(+) toxicity was not solely responsible for fish mortality in acid water. (Murphy-IVI) W34-03316

REDD-SITE SELECTION BY BROOK TROUT AND BROWN TROUT IN SOUTHWESTERN ONTARIO STREAMS,

Guelph Univ. (Ontario). Dept. of Zoology. L. D. Witzel, and H. R. MacCrimmon.

Transactions of the American Fisheries Society, Vol. 112, No. 6, p 760-71, November, 1983. 3 Fig. 6 Tab, 43 Ref. National Sciences and Engineering Research Council of Canada grant A1719.

Descriptors: \*Fish behavior, \*Streams, \*Habitats, Canada, Ontario, Trout, Fish, Aquatic habitats.

Redd-substrate composition, water velocity, depth, and other environmental variables associated with redd-site selection and spawning by brook trout and brown trout were examined in southwestern and orown trout were examined in southwestern Ontario streams. Sympatric and allopatric populations spawned in similar ranges of specific conductance (225-810 micromhos/cm), pH (7.0-8.2), dissolved oxygen (greater than 83% saturation), and stream gradient (0.2-2.3%). Brook trout and stream gradient (0.2-2.3%). Brook trout spawned only in areas of groundwater seepage, typically near headwaters where streamflow did not exceed 177 liters/second. Brown trout spawned in a wider range of flows and used locations both with and without groundwater seepage. Reuse of redds was mostly intraspecific. Mean water depth over redds selected by brook and brown trout were similar. However, mean stream velocities were significantly slower at brook trout (17.6 cm/second). Redd-site preference by brook trout for the areas of groundwater seepage and by for the areas of groundwater seepage and by brown trout for faster water velocities and coarser substrates minimized species interactions during spawning. (Baker-IVI) W84-03320

REPRODUCTION BY THE ENDANGERED CUI-UI IN THE LOWER TRUCKEE RIVER, Fish and Wildlife Service, Reno, NV.

G. G. Scoppettone, G. A. Wedemeyer, M. Coleman, and H. Bruge.

Transactions of the American Fisheries Society, Vol. 112, No. 6, p 788-793, November, 1983. 5 Fig.

Descriptors: \*Fish behavior, \*Rivers, Cui-ui, Lower Truckee River, Reproduction, Fish, Aquatic habitats, Habitats, Reproducibility

The cui-ui is an endangered species endemic to Pyramid Lake, Nevada, and is thought to be the Pyramid Lake, Nevada, and is thought to be the sole surviving genetically pure member of its genus. Water-project developments dating back to the turn of the century have regulated Truckee River flows and diverted water for agricultural and municipal uses. As a result, the level of Pyramid Lake dropped approximately 25 m, and a large shallow delta formed at the mouth of the river. Adult spawning behavior and emigration of larvae of the endangered cui-ui Chasmistes cujus were of the endangered cui-ui Chasmistes cujus were studied in a natural side channel of the lower Truckee River. The river phase of cui-ui life appeared to be extremely brief. Most migratory and spawning activity occurred at night. The external radio-tags apparently did not affect spawning behavior. Adults spawned over predominantly gravel substrate under a broad range of water depths and velocities. Eggs were buried to about 10 cm in the substrate. Cui-ui larvae apparently emigrated downstream to Pyramid Lake immediately after swim-up. (Baker-IVI)

SULPHUR AND CHLORIDE DEPOSITION AND ECOSYSTEM TRANSPORT IN A STRONGLY ACIDIFIED LAKE WATERSHED, Swedish Water and Air Pollution Research Lab Goeteborg.

For primary bibliographic entry see Field 5B. W84-03388

COMPARATIVE WATER CHEMISTRY OF FOUR LAKES IN ROCKY MOUNTAIN NA-

TIONAL PARK, National Park Service, Fort Collins, CO. Water Resources Field Support Lab.

Water Resources Bulletin, Vol. 19, No. 6, p 897-901, December, 1983. 2 Fig. 2 Tab, 11 Ref.

Descriptors: "Water chemistry, "Mountain lakes, "Rocky Mountain National Park, Colorado, Chemical properties, Inorganic compounds, Biological filters, Weathering, Nitrates, Sulfates.

Lake chemistry is the product of its inputs, components of which include weathering of primary parent materials and soils, biological leachates, and precipitation. The inorganic chemistry of four high

altitude lakes which appear similar superficially altitude lakes which appear similar was compared to determine what controls variation between them. Weathering from the different types of parent material caused differing cation types or parent material caused differing cation concentrations between the lakes by dissimilar concentrations of those cations which are products of primary weathering. There was a significant difference in anion concentrations between members of ence in anion concentrations between members of one pair having the same bedrock geology. This difference is attributed to the presence of a wet sedge meadow above one of the lakes which serves as a biological filter for anions, particularly nitrate and sulfate. Small scale drainage characteristics which can alter regional atmospheric contributions are important contributors to lake chemistry. (Murphy-IVI) W84-03393

TRANSPORT IN LAKE WATER QUALITY MODELING, Environmental Research and Technology, Inc.,

Concord, MA

P. Shanahan, and D. R. F. Harleman. No. 1, p 42-57, February, 1984. 3 Fig, 25 Ref. NSF grant CEE-7906125.

Descriptors: \*Lakes, \*Water quality, \*Model studies, Dispersion, Diffusion, Mathematical models, Hydrodynamics, Finite difference models, Multi-

An important aspect of lake water quality modeling is the transport due to diffusion and dispersion processes. The determination of dispersive transport is examined relative to model spatial structure and numerical formulation. Two basic model types are identified: the finite difference model (a continuum approach); and the multiple-box model (a discrete approach). Analysis of these two approaches indicates that the multiple-box model formulation introduces substantial implicit dispersion as a consequence of its discrete structure. Due to this implicit dispersion, multiple-box model ex-change flow or dispersion parameters cannot be determined directly based on the hydrodynamics of the prototype lake - only calibration is a viable approach. Despite the conceptual advantages of finite difference models over box models, box models will continue to be used as a simple and models will continue to be used as a simple and cost-effective alternative for lake water quality modeling. Box models can serve as a reasonable approximation provided the implicit model dispersion is properly considered in model formulation. Guidelines are recommended for construction of multiple-box lake water quality models. (Moore-WO) IVD W84-03469

MULTILEVEL WITHDRAWAL AND WATER

QUALITY, Ecole Nationale des Ponts et Chaussees, Paris (France)

Journal of Environmental Engineering, Vol. 110, No. 1, p 123-129, February, 1984. 6 Fig, 6 Ref.

Descriptors: "Selective withdrawal, "Water quality, "Mathematical models, Reservoir operation, Reservoir releases, Outlets, Stratification, Grangent Reservoir, France.

The efficiency of selective withdrawal depends on In efficiency of selective withdrawal depends on the type of reservoir, hydrologic conditions, inflow water quality and water quality objectives. A water quality simulation model appears to to be one of the better tools for synthesizing all such data for determining relationships between water quality, outlet locations and reservoir operation. A one dimensional vertical model of water quality in one dimensional vertical model of water quality in reservoirs was developed, calibrated, and verified using data for the years 1978 and 1979 from Grangent reservoir in France. The model was used for the study of the influence of outlet location on both reservoir and outflow water quality. Three different outlet locations were considered on the Grangent reservoir, as well as various conditions in inflow water quality, reservoir size and reservoir operation. The reservoir water quality model appears to be particularly efficient for the study of pears to be particularly efficient for the study of the complex relations between outflow water qual-

ity, outlet location, and water quality stratification in the reservoir. (Moore-IVI) W84-03472

STRATIFICATION AND MIXING IN LAKES OF TAYLOR COUNTY, WISCONSIN, WITH EMPHASIS ON RICHTER LAKE, State Univ. of New York at Buffalo. Dept. of

ogical Sciences Biological Sciences. K. M. Stewart, and W. A. Stewart. Archiv fur Hydrobiologie, Vol. 98, No. 2, p 250-264, October, 1983. 6 Fig, 3 Tab, 29 Ref.

Descriptors: \*Stratification, \*Mixing, \*Winterkill, \*Richter Lake, \*Wisconsin, Glacial kettle lakes, Dissolved oxygen, Ice cover.

A limnological investigation was carried out on eight lakes (Diamond, Eska, Kathryn, Nineteen, North Twin, Richter, Spruce, and Thirty-three) in the lower Chequamegan National Forest in Taylor County, Wisconsin. The glacial kettle lakes range in area from 2.6 to 25 ha and in depth from 9.1 to 2.0 to 2.5 with the lakes and the property of the county o 19.2 m. Winterkill occurs in some of these lakes as an occasional or aperiodic event, whereas in others the phenomenon occurs annually with varying de-grees of severity. Because most of the lakes are grees of severity. Because most of the lakes are relatively deep with respect to surface area, an explanation for the poor to marginal oxygen conditions was sought. Richter Lake was selected for the most detailed studies. If its vernal and autumnal mixing are fairly representative, then problems of aperiodic winterkill in these small but relatively deep lakes are more easily understood. Richter has long periods of ice and snow cover, a strong winter and summer stratification, an incomplete vernal mixing, and only a brief period of complete vernal mixing, and only a brief period of complete autumnal mixing. The lake does not have time to achieve full oxygen saturation in either spring or autumn before the lake restratifies, thus perpetuatautum before the lake restratines, thus perpetual-ing marginal conditions which are probably inad-equate to handle the organic loading from this mostly forested region. The Secchi visibilities are generally low in these moderately stained waters. Lake Thirty-three has some meromictic characteristics. (Moore-IVI) W84-03491

PRELIMINARY MEASUREMENTS OF PRI-MARY PRODUCTION AND COMMUNITY RESPIRATION IN A FOREST STREAM IN

NOR KONG,
Hong Kong Univ. Dept. of Zoology.
D. Dudgeon.
Archiv fur Hydrobiologie, Vol. 98, No. 3, p 287-298, November, 1983. 5 Fig, 29 Ref.

Descriptors: \*Primary productivity, \*Respiration, \*Forest streams, \*New Territories, \*Hong Kong, Lotic environment, Energy, Dissolved oxygen,

Comparative measurements of primary production (P) and community respiration (R) were undertaken in a shaded riffle reach and an unshaded pool in Tai Po Kau Forest Stream, New Territories, Hong Kong. It was hoped that such a study would enable an assessment of the relative importance of all country and any control of the relative importance of all country and any control of the relative importance of all country and any control of the relative importance of all country and any control of the relative importance of the relative i allochthonous and autochthonous carbon sources to the energy budget of the stream as a whole to be to the energy budget of the stream as a whole to be made. The procedure employed was the twin curve method involving measurements of dissolved oxygen concentrations at regular intervals over a 24-hour period. Such procedures have rarely been employed in studies of lotic habitats in Asia. Calculated P/R ratios varied between 1.02 in the shaded pool site and 0.17 in the shaded riffle reach. P values recorded in the pool site were considerably higher than these recorded in uncelreach. P values recorated in the pool site were considerably higher than those recorded in unpol-luted streams in temperate regions. Despite this, it was apparent that the bulk of the energy require-ments of the consumers in Tai Po Kau Forest Stream were met from allochthonous sources, such a characteristic probably typifying the metabolism of lotic habitats in forest watersheds. (Author's abstract) W84-03492

RELATIONSHIPS AMONG CHEMICAL. BIOLOGICAL INDICES PHYSICAL, AND

ALONG RIVER CONTINUA BASED ON MUL-TIVARIATE ANALYSES,

Battelle Pacific Northwest Labs., Richland, WA. Environmental Sciences Dept. C. E. Cushing, C. D. McIntire, K. W. Cummings, G. W. Minshall, and R. C. Petersen.

Archiv fur Hydrobiologie, Vol. 98, No. 3, p 317-326, November, 1983. 2 Fig. 3 Tab, 26 Ref. NSF grants BMS-75-07333 and DEB-7811671.

Descriptors: \*Multivariate analysis, \*River Continuum Concept, \*Stream classification, Physical properties, Biological properties, Chemical proper-ties, Respiration, Ecosystems, Precipitation, Stream gradient, Stream length, Watersheds.

A variety of multivariate analyses were applied to chemical, physical, and biological data from 16 stream sites to explore the usefulness of these fac-tors in possible stream classification systems and to test hypotheses of the River Continuum Concept. High positive correlations were found between stream gradient and the ratio of shredder to collecstream gradient and the ratio of shredder to collec-tor organisms and between benthic respiration and high ratio of FBOM to CBOM; a high negative correlation was found between P/R ratio and high shredder to grazer ratio. These and other results support predictions of the River Continuum Con-cept. Ordination analyses of the untransformed bio-logical data and of the total data base resulted in markings of the variables suggestion of a gradetice. rankings of the variables suggestive of a gradation from those characteristics of low order (1-2) streams to those characteristics of higher orders (4-6). In general, the overall ordination rankings of 6). In general, the overall official managers of the stream sites also were suggestive of a low to high order continuum. Correlation of ordination scores of the untransformed biological data with the different physical-chemical variables suggested that precipitation, gradient, and stream length to watershed area best explained the ordination rankwatershed area best explained the ordination rank-ings, and that the shredder to collector ratio, shredder to grazer ratio, UBOM to CBOM ratio, FBOM to CBOM ratio, and gross production were the most influential biological variables. Findings suggest that streams are best viewed as gradients, or continua, and that classification systems which separate discrete reaches are of little ecological value. (Author's abstract)

THE IMPORTANCE OF ATTACHMENT TO PARTICLES FOR PLANKTONIC BACTERIA, Universidad Autonoma de Barcelona (Spain).

Dept. de Microbiologia. C. Pedros-Alio, and T. D. Brock.

Archiv fur Hydrobiologie, Vol. 98, No. 3, p 354-379, November, 1983. 5 Fig, 6 Tab, 93 Ref.

Descriptors: \*Plankton, \*Bacteria, \*Particles, \*Bacterioplankton, Epilimnion, Biomass, Sedimen-tation, Hydraulic flushing, Zooplankton, Lake Mendota, Wisconsin.

The importance of attachment to particles for he-In emportance of attachment to particles for ne-terotrophic bacteria in the epilimnion of Lake Mendota, Wisconsin, was analyzed. Attached bac-teria constituted from 1% (in winter) to 30% (in summer) of the total cell counts obtained by epi-fluorescence. When biomass was calculated from counts and volumes measured in scanning electron micrographs, attached bacteria contributed up to 50% of the total biomass. Three indicators of bac-terial activity were measured separately for atterim activity were measured separately for at tached and freeliving bacteria: frequency of divid-ing cells (FDC), dark sulfate uptake, and acetate uptake. Attached bacteria were bigger, had higher FDC, and were responsible for most of the acetate uptake. Free-living bacteria were smaller with lower FDC, and responsible for most of the sulfate uptake. Using this information and results from other studies, hydraulic flushing of the system, abundance of particles, sedimentation, and feeding by zooplankton were considered to be the most important factors in regulating what percent of the bacterioplankton activities and biomass is due to attached bacteria in a given system. (Author's abstract) W84-03495

#### Group 2H-Lakes

CALCITE PRECIPITATION AS A NATURAL CONTROL MECHANISM OF EUTROPHICA-

TION,
Zentralinstitut fur Mikrobiologie und Experimen-telle Therapie der Akademie der Wissenschaften der DDR, Jena. Abt. Limnologie.
R. Koschel, J. Benndorf, G. Proft, and F.

Recknagel. Archiv fur Hydrobiologie, Vol. 98, No. 3, p 380-408, November, 1983. 15 Fig. 5 Tab, 58 Ref.

Descriptors: \*Calcite precipitation, \*Eutrophica-tion, \*Lake Breiter Lucin, \*East Germany, Phos-phorus, Phytoplankton, Light transmission, Algae, Flocculation, Model studies.

The observations of calcite precipitation in the deep mesotrophic Lake Breiter Lucin (Germany, D.R.) indicated that calcite precipitation is connected with a decrease in dissolved and total phosnected with a decrease in dissolved and total phosphorus, phytoplankton biomass and light transmission. Additional investigations in other lakes of the same geographical region show that the maximum of calcite in the sinking material is found 2 to 4 weeks after the maximum of primary production of phytoplankton. The calcite content of the profundal sediments exhibits high values in eutrophic especially in mesotrophic lakes and small values in oligotrophic lakes. All the observations show that calcite precipitation must be linked with a control mechanism which acts as a natural self-protection mechanism which acts as a natural self-protection of the lakes against eutrophication. The most probable hypotheses to answer the question, why calable hypotheses to answer the question, why cal-cite precipitation acts as a control mechanism of lake eutrophication, were specified as scenarios and checked by means of the dynamic ecological model SALMO. From the scenario analysis the conclusion can be drawn only that self-flocculation of the algae is the dominating mechanism which is responsible for the self-protection of these lakes against eutrophication. (Author's abstract)

LIGHT ATTENUATION IN ONONDAGA LAKE, NY, USA, 1978, Louisiana State Univ., Baton Rouge. Dept. of Civil

Engineering. S.D. Field, and S. W. Effler. Archiv fur Hydrobiologie, Vol. 98, No. 4, p 409-421, November, 1983. 5 Fig. 1 Tab, 31 Ref.

Descriptors: \*Light penetration, \*Lakes, Lake On-ondaga, New York, Algae, Phytoplankton, Eutro-phication, Light intensity, Productivity.

The partitioning of attenuation of photosynthetically active radiation (PAR) between the phytoplankton of Onondaga Lake and their environment was evaluated for 7 months. The estimates of the attenuation coefficients for chlorophyll-a, k(c), and for water and its nonphytoplankton components were within the range reported in the literature. The phytoplankton of the lake were dominated by chlorophytes. The phytoplankton failed during the study period to reach levels at which self-shading would be a significant influence. One hundred and eighteen parallel observations of light attenuation and chlorphyll-a were included in the analysis. These attenuation characteristics, in combination with the observed chlorophyll-a levels, are interpreted with respect to their influence on the relative rate of integral photosynthesis within the lake. The critical role the assessment of these characterristics plays in the calibration of a phytoplankton productivity model for the lake is described. (Baker-IVI)

DIEL OXYGEN VARIATIONS AND THEIR EC-OLOGICAL IMPLICATIONS IN AMAZON FLOODPLAIN LAKES, California Univ., Santa Barbara. Dept. of Biologi-

cal Sciences.

J. M. Melack, and T. R. Fisher.

Archiv fur Hydrobiologie, Vol. 98, No. 4, p 422-442, Stuttgart, November, 1983. 13 Fig. 1 Tab, 33

Descriptors: \*Dissolved oxygen, \*Diel variations, Mixing, Nutrients, Lago Calado, Brazil, Amazon floodplain, Photosynthesis, Epilimnion, Hypolimnion, Phosphates, Ammonium, Organic matter.

Eighty diel cycles of dissolved oxygen were measured during a sixteen month period in Lago Calado, an Amazon floodplain lake. While planktonic photosynthesis is modest, air-water ex-changes, vertical mixing and perhaps advection can strongly influence diel oxygen variations. Influx of oxygen from the atmosphere is a major source of dissolved oxygen. A conspicuous feature of oxygen content is erratic variation between periof oxygen content is erratic variation between periods of positive or negative rates of oxygen change during both day and night. An important implication of the episodes of vertical mixing indicated by the dissolved oxygen variations is the injection of nutrients such as phosphate and ammonium from the hypolimnion into the epilimnion. Diffusion-corrected, daytime changes in oxygen content clearly indicate that on most days the net dissolved oxygen change is negative. The main implication of this result is that the biota of Lago Calado consumes more organic matter than is produced. consumes more organic matter than is produced autochthonously. W84-03498

THE SEASONAL VARIATION OF ORGANIC CONSTITUENTS IN A EUTROPHIC LAKE, LAKE SUWA, JAPAN; PART II. DISSOLVED ORGANIC MATTER, Nagoya Univ. (Japan). Water Research Inst. T. Hama, and N. Handa.

Archiv fur Hydrobiologie, Vol. 98, No. 4, p 443-462, Stuttgart, November, 1983. 11 Fig, 40 Ref.

Descriptors: \*Eutrophic lakes, \*Lake Suwa, \*Japan, \*Dissolved organic matter, Carbohydrates, Proteins, Amino acids, Acetic acid, Diatoms, Microcystis, Seasonal variation, Phytoplankton.

Water samples were collected from Lake Suwa, Water samples were collected from Lake Suwa, one of the most eutrophic lake in Japan, once a month from April, 1979 through August, 1980 and analyzed for dissolved organic carbon, carbohydrates, protein (including amino acids) and acetic acid. The molecular weight distribution of dissolved organic matter (DOM) in each of the water samples was also tested by the gel-filtration technique. Dissolved organic carbon (DOC) concentrations ranged from 1.4 to 3.4 mg C/L, and varied easaonally in close relation to the seasonal change in the standing stock and species composition of phytoplankton. Diatom and Microcystis aeruginosa had a great influence over the concentration of DOC in this lake. Scasonal distribution profiles of dissolved carbohydrates, protein and acetic acid dissolved carbohydrates, protein and acetic acid differed little from that of DOC. Polysaccharides consisting of glucose, galactose, xylose, and rham-nose and of galactose, rhamnose and fucose were found in the water samples when M. aeruginosa and diatom blooms occurred respectively. Extracellular production of polysaccharide(s) by phyto-plankton was evidenced. There were seasonal changes in molecular weight distribution of dissolved carbohydrates and proteins. Poly- and oligosaccharides were key substances determining the concentration of dissolved carbohydrate in this lake, while all components of the proteinous materials changed their concentration irrespective of molecular weight. (Moore-IVI) W84-03499

THE GEOCHEMICAL RECORD OF MAJOR CATIONS AND TRACE METALS IN A PRODUCTIVE LAKE; ANALYSIS OF THINLY SLICED SEDIMENT SAMPLES CHARACTERISED BY DIATOM STRATIGRAPHY, Freshwater Biological Association. Ambleside

Biological (England) U. Ochsenbein, W. Davison, J. Hilton, and E. Y.

Haworth. Archiv fur Hydrobiologie, Vol. 98, No. 4, p 463-488, Stuttgart, November, 1983. 6 Fig. 6 Tab, 51

Descriptors: \*Geochemistry, \*Trace metals, \*Diatoms, \*Sediments, Minerals, Heavy metals, Water pollution sources, Lead, Cadmium, Zinc, Stratigraphy, Blelham Tarn, England.

The concentration-depth behavior of Mg, K, Al, Fe, Mn, Cu, Ni, Zn, Cd, Pb, C, percentage mineral matter and water content of a sediment core from Blelham Tarn, a small productive lake in the Eng-

lish Lake District, was examined at 0.5 intervals over a 600 year period. Detailed algal stratigraphic evidence suggested that the supply of all elements is free from large annual fluctuations. Peaks in the concentration of carbon, iron and other trace concentration of carbon, iron and other trace metals were tentatively attributed to an inflow of humic material. X-ray diffraction analysis of the minerals showed that leaching of Mg from chlorite has not played a significant role in its recruitment to the sediments. Mg, K, Al, Fe and Ni were largely of mineralogical origin. The profile shapes of organic carbon and manganese are related and can be rationalized in terms of the rapid redox-cycling of manganese at the sediment-water interface. Pb, Cd and Zn all show elevated concentrations, which systematically decrease during the past 10 years. Consideration of fluxes indicates that this pollution can not be accounted for by direct this pollution can not be accounted for by direct deposition of air-borne metal onto the lake surface. Elevated anthropogenic Pb concentrations appear before the equivalent increase in other metals. (Author's abstract)

COMPOSITIONAL CHANGES OF FATTY ACIDS IN PARTICULATE MATTER AND WATER TEMPERATURE, AND THEIR IMPLICATIONS TO THE SEASONAL SUCCESSION OF PHYTOPLANKTON IN A HYPEREUTROPHIC LAKE, LAKE KASUMIGAURA, JAPAN, Tsukuba Univ., Ibaraki (Japan). Inst. of Biological

T. Miyazaki. Archiv fur Hydrobiologie, Vol. 99, No. 1, p 1-14, December, 1983. 6 Fig, 31 Ref.

Descriptors: \*Fatty acids, \*Lakes, Japan, Lake Ka-Descriptors: Party acids, "Lakes, Japan, Lake Ra-sumigaura, Eutrophication, Seasonal variations, Phytoplankton, Temperature effects, Water tem-perature, Particulate matter, Sediments.

Seasonal succession of phytoplankton in lake ecosystems takes place through interactions of physical, chemical, and biotic factors. Temperature, among others, affects many biochemical reactions of phytoplankton, and is one of the most important factors in understanding mechanisms of the season-al succession. Fatty acids were considered to originate from phytoplankton because of a good corre-lation between the amounts of fatty acids and nate from physical lation between the amounts of fatty acids and chlorophyll-a. The percentage of unsaturated fatty acids showed a remarkable relation to water temperature: the percentage was higher and constant at lower temperatures and decreased to about 40% at lower temperatures and decreased to about 40% to the control of the cont er, this percentage had no correlation with the amount of inorganic nitrogen. These findings sugamount of inorganic nitrogen. These moltings sug-gest that water temperature played an important role in determining the percentage of unsaturated fatty acids in phytoplankton. Moreover, fatty acid composition and chlorophylls-b and c varied cor-respondingly, reflecting the change in phytoplank-ton species throughout the year. (Baker-IVI) W84-03501

DEGRADABILITY OF DISSOLVED ORGANIC LAKE WATER COMPOUNDS IN CULTURES OF NATURAL BACTERIAL COMMUNITIES, Konstanz Univ. (Germany, F.R.). Limnological

Archiv fur Hydrobiologie, Vol. 99, No. 1, p 60-79, December, 1983. 8 Fig, 3 Tab, 30 Ref.

Descriptors: \*Dissolved solids, \*Biodegradation, \*Bacteria, Lakes, Chemical properties, Dissolved organic carbon, Microbial degradation.

Dissoved organic matter in lakes is mainly composed of a range of oligomeric to macromolecular compounds derived from autochthonous produccompounds derived from autochthonous produc-tion and allochthonous input. Ninety percent of dissolved organic carbon (DOC) of Mindelsee con-sisted of macromolecular (MW > or = 1500) and oligomeric (MW 400-800) components which were isolated during the four seasons. The compounds were subjected to degradation by natural bacterial communities present in the lake at the same time. Regardless of season the lake water constituents were largely resistant to microbial attack during

#### Water In Plants-Group 21

the three months incubation period in four of five experiments as shown by DOC measurements. Refractory macromolecules and oligomers depressed growth of bacteria as established by the microcolony method. Less persistent macromolecules growth of bacteria as established by the microco-lony method. Less persistent macromolecules found in one of the experiments, consisted of minor constituents which were utilized by various bacte-ria and a remainder which was decomposed only by specialists forming characteristic microcolonies. Accompanying oligomers consisted of 40%-50% of readily degradable substances and of a remain-der, which was inaccessible to the major part of the bacteria. (Murphy-IVI) W84-03503

#### 2I. Water In Plants

GROWTH KINETICS OF MICROCYSTIS AER-UGINOSA (KUTZ) KUTZ AS A BASIS FOR MODELLING ITS POPULATION DYNAMICS, Humboldt-Univ. zu Berlin (German D.R.). Sektion

A. Nicklisch, and J.-G. Kohl. Internationale Revue der Gesamten Hydrobiologie, Vol. 68, No. 3, p 317-326, 1983. 1 Fig, 4 Tab, 33 Ref.

Descriptors: \*Algal growth, \*Population dynamics, \*Lakes, \*Microcystis, Growth, Kinetics, Eutrophication, Nutrients, Temperature effects, Light intensity, Water quality, Algae.

The dependence of the specific growth rate of Microcystis aeruginosa (Kutz) Kutz f. aeruginosa upon temperature and light intensity was determined under continuous illumination by the analymined under commous illumination by the analysis of the exponential growth period in batch cultures. Light dependence at the optimum temperature is well described by Michaelis-Menten kinetics. The maximum specific growth rate decreases with decreasing temperature, but the initial slope of the curve does not change, although the flexure of the light dependence curve increases. Therefore, the light dependence at lower temperatures is better described by the model of Smith. The Kf values for the light dependence curves decrease with temperature in about the same manner as the maximum specific growth rates. The temperature dependence of the specific growth rate up to the acpenience of the specific growth rate up to the optimum is well described by a sigmoid curve. The results regarding the interaction between temperature and light can be described by combining the light and temperature dependence. The Ks values for orthophosphate, nitrate and ammonium were determined at 25 degrees C and 24 W/sq m light intensity by measuring the steady state nutrient concentrations of nutrient limited chemostat cultures at a dilution rate of 0.5 micromax. The values obtained characterize M. aeruginosa as an alga of eutrophic waters which reaches high growth rates at even moderate phosphate and nitrate concentra-tions. (Baker-IVI) W84-02954

THE RELATIONSHIP BETWEEN NUTRIENT AVAILABILITY, SHOOT BIOMASS AND SPECIES RICHNESS IN GRASSLAND AND WET-

CIES RICHNESS IN GRASSLAND AND WET-LAND COMMUNITIES, (Netherlands). Dept. of Landscape Ecology and Nature Management. J. G. Vermeer, and F. Berendse. Vegetatio, Vol. 53, No. 2, p 121-126, September, 1983. 2 Tab, 29 Ref.

Descriptors: \*Wetlands, \*Grasslands, \*Biomass, Nutrients, Moisture availability, Eutrophication,

A possible relationship between shoot biomass, nu trient concentration in the soil and number of species per unit area was studied in two different parts of the Netherlands: the Gelderse Vallei and the Westbroekse Zodden. Samples were taken of four series of vegetation and soil studies. One series was located in grassland and wetland communities, one in grassland communities, one in fen communities and one series in only one wetland community. The two series in grassland communities showed a negative correlation between shoot biomass and nutrient concentration in the soil. The opposite

was found in the series in the fen communities: there was a positive correlation between species number and shoot biomass and a negative correlation between shoot biomass and nutrient concentrations. The series of samples that had been taken in only one wetland community showed an optimum curve for the relation between shoot biomass and number of species. In the plant communities studied the species richness per unit area increases with increasing productivity at low production levels of less than 400-500 g/sq m, and decreases with increasing productivity at higher production levels greater than 400-500 g/sq m. It is possible to construct an optimum curve for the relationship between species number per unit of area and shoot biomass from these findings. However, the optimum can be expected to differ from one plant community to another. (Baker-IVI) was found in the series in the fen communities:

THE DERIVATION AND VALIDATION OF A NEW MODEL FOR THE INTERCEPTION OF RAINFALL BY FORESTS,

on Univ., Eugene. Dept. of Biology. Oregon Univ., E W. J. Massman.

Agricultural Meteorology, Vol. 28, No. 3, p 261-286, 1983. 3 Fig, 3 Tab, 44 Ref. NSF Grant DEB

Descriptors: \*Rainfall, \*Forests, Canopy, Model studies, Forest hydrology, Mathematical equations, Storms, Precipitation, Vegetation effects, Evapora-tion, Interception, Drainage, Water loss, Intercep-

A dynamic model and an analytical model derived from it can predict the gross interception of forest canopies. The dynamic model is validated using a running balance in time between rainfall, throughrunning balance in time between rainfall, throughfall, evaporation and changes in the canopy storage. The canopy storage is increased by rainfall interception and depleted by evaporation and depleted to a varies with the amount of water in the canopy and is estimated by numerical methods because sufficient meteorological data is not available. Drainage rate expressions are shown to be inadequate during the period of rainfall. A new drip expression which explicitly includes the rain rate, in addition to the stored water, is proposed and tested and found to fit the observed drip rate better, giving significantly better model prediction with fewer empirical parameters than the exponential form of drip rate. rameters than the exponential form of drip rate. The dynamic model was simplified to an analytical model for predicting the gross interception loss. This analytical expression is easier to use as it is not This analytical expression is easier to use as it is not sensitive to the exact value of the drip parameters. It predicted the total observed gross interception loss for the 20 storms tested to within 4%. The new drip expression is recommended for use in the dynamic model as it described better the dislodgement of peviously intercepted rain droplets by falling rain droplets. A new model for estimating railing rain droplets. A new model for estimating evaporation rates from forest canopies is also proposed. The evaporation model was derived assuming that the thermal diffusivity is a constant throughout the tree canopy and that the Bowen ratio and other micrometeorological parameters can be suitably averaged over the duration of a rainsform. (Baker-IVI)

WATER STRESS AND WATER-USE EFFICIEN-CY IN FIELD GROWN WHEAT: A COMPARI-SON OF ITS EFFICIENCY WITH THAT OF C4

PLANTS, Indian Agricultural Research Inst., New Delhi. Water Technology Center. P. K. Aggarwal, and S. K. Sinha. Agricultural Meteorology, Vol. 29, No. 3, p 159-167, 1983. 3 Fig, 1 Tab, 26 Ref.

Descriptors: \*Water stress, \*Plant growth, \*Water use efficiency, Wheat, Canopy, Evaporation, Drought, Irrigation, Regression analysis, Statistical

Breeding for water-use efficiency (WUE) is an important objective for the improvement in grain yield of crops grown in rain-fed areas. Water-use efficiency can be improved by either reducing the

water use or increasing the dry matter production. Two cultivars of wheat, contrasting in their drought resistance characteristics, were grown drought resistance characteristics, were grown under irrigated and non-irrigated conditions in the field for two seasons. The WUE ranged from 0.5 to 13.8 g dry matter/kg water used depending upon the growth stage, cultivar and water stress. The average WUE for the season was between 3.34 and 4.70 g dry matter/kg water used. Regression analysis indicated that WUE was a function of dry matter produced and had no direct statistical relationship with the weather parameter. The relationship with the weather parameters. The WUE of plants having the C3 system of photosynthesis, like wheat, need not be poorer than that of plants with the C4 system, if comparisons are made plants with the C4 system, it comparisons are made of plants growing in their respective preferred ecological niches. The observed values of WUE in these experiments would be higher still if the weight of roots and loss of water by evaporation were also considered. One possible reason for the difference between these observed values and the reported values of WUE in the literature is that, under conditions of solution cultures or in pots maintained at field capacity, in the absence of mantained at nein capacity, in the absence of canopy effects, a greater vapour pressure gradient would be established between the evaporating surfaces (leaves and soil) and the atmosphere resulting in excessive water loss without any concomitant increase in dry matter production. (Baker-IVI)

WATER BALANCE OF THREE IRRIGATED CROPS ON FINE-TEXTURED SOILS OF THE RIVERINE PLAIN,

Commonwealth Scientific and Industrial Research Organization, Griffith (Australia). Div. of Irrigation Research.

W. K. Mason, W. S. Meyer, R. C. G. Smith, and

Australian Journal of Agricultural Research, Vol. 34, p 183-191, 1983. 5 Fig, 3 Tab, 29 Ref.

Descriptors: \*Hydrologic budget, \*Irrigation, \*Soil texture, \*Riverine Plain, Maize, Sorghum, Sunflower, Plant growth, Moisture uptake, Capillary conductivity, Crop yield, Soil-water-plant re-

Since irrigation from the Murray and Murrumbid-gee rivers began on the Riverine Plain of south-eastern Australia, agricultural production has gradually intensified and the amount of water used has increased. Three summer crop species, maize, sorghum and sunflower were grown on three dif-ferent fine-textured soils of the Riverine Plain in south-eastern Australia. At each site, above-ground growth, phenological development, and root length density were measured in two well-watered plots to determine the water requirements of the plants. Water use, plant water status and final crop yield were measured in the well-watered plots and in one plot per site where irrigation was discontinued and the site of the status and second and the piot per site where irrigation was usediminuded around the time that complete crop canopies had developed. Plant available water was estimated from these drying-cycle plots. Crop water use calculated from soil water contents did not agree with estimates from a water balance model at two
of the sites, suggesting that capillary rise from
shallow water tables was supplying considerable
quantities of water to the crops. Using the water
balance model to predict actual evapotranspiration (E sub t), after complete canopy development, up to 40% of E sub t, was supplied to well-watered crops from a water table at approximately 1.5 m. At the site without a water table, yields from the At the site without a water table, yields from the estimate of plant available water (PAW) was thought to be realistic. Where capillary rise or lateral movement of water into the root zone was significant, the concept of plant available water (PAW) was unsatisfactory. (Murphy-IVI) W84-03238

PERENNIAL RYEGRASS GROWTH, WATER USE, AND SOIL AERATION STATUS UNDER SOIL COMPACTION,

Kansas State Univ., Manhattan. Dept. of Horticul-

K. J. O'Neil, and R. N. Carrow.

#### Field 2-WATER CYCLE

#### Group 21-Water in Plants

Agronomy Journal, Vol. 75, No. 2, p 177-180, March-April, 1983, 5 Tab. 24 Ref.

Descriptors: \*Perennial Ryegrass, \*Plant growth, \*Water use, \*Soil aeration, \*Soil compaction, Soil physical properties.

Soil compaction is a serious problem on recreational turfgrass sites because the altered soil physical properties can adversely affect plant growth and irrigation management. Soil compaction was examined in a greenhouse study for its effect on turfgrass growth, water use, and soil aeration using a Chase sit loam soil (fine, montmorillonitic, mesic, Aquic Arquidolls). Perennial ryegrass (Lolium perenne L. 'Derby') was subjected to three compaction levels: 1) none-no compaction, 2) moderate-360 joules energy, and 3) heavy-720 joules energy. The soil was compacted by dropping a 11.5 kg 360 joules energy, and 3) heavy-720 joules energy. The soil was compacted by dropping a 11.5 kg weight from a height of 65 cm. When tenslometers (installed at a depth of 5 cm.) read-0.65 bar, 5 cm of water was applied. Pots were 30.5 cm I.D. by 76.2 cm long PVC pipe with bottom drainage. Soil compaction increased bulk density; reduced aeration porosity, visual quality, and shoot density; in the 10 to 25 cm soil zone. It had, however, slight effect on verture and individual shoot weight. in the 10 to 25 cm soil zone. It had, however, slight effect on verdure and individual shoot weight. Total clipping weights were reduced by 38 and 53% for the moderate and heavy compaction treatments, respectively. Clipping yield decreased immediately after compaction treatment, while root changes were not apparent until after 12 weeks. Water use was reduced by 21 and 49% for the moderate and heavy compaction treatments, respectively. Water extraction from the 10 to 25 cm soil zone decreased from 69 to 27% of the total spectively. Water extraction from the 10 to 25 cm soil zone decreased from 69 to 27% of the total water extracted in the heavy compacted pots by the end of the study. With heavy compaction, oxygen diffusion rates (ODR) were below 20 x ten to the minus 9th power g/sq cm/min for at least 53 hours after irrigation. The noncompacted soil achieved acceptable ODR within 5 hours. The combined effects of compaction reducing rooting, slowing shoot growth, and increasing moisture retention, caused the compacted soil to remain at a reduced aeration status longer than the noncompacted soil after irrigation. (Murphy-IVI) W84-03240

ROOT DISTRIBUTION AND WATER USE EF-FICIENCY OF ALFALFA AS INFLUENCED BY DEPTH OF IRRIGATION, Mississippi State Univ., Mississippi State. Dept. of

Agronomy. F. Jodari-Karimi, V. Watson, H. Hodges, and F.

Agronomy Journal, Vol. 75, No. 2, p 207-211, March-April, 1983. 3 Fig, 3 Tab, 18 Ref.

Descriptors: \*Root distribution, \*Water use efficiency, \*Alfalfa, \*Irrigation, Irrigation efficiency, Moisture availability, Moisture stress. Evapotranspiration.

Root distribution of several crop plants is affected by different patterns of soil moisture. In alfalfa (Medicago sativa L.), however, such results have not been consistently obtained under field condi-tions. The effect of different irrigation depths on alfalfa transparence efficiency water astrontom. tions. The effect of different irrigation depths on alfalfa water use efficiency, water extraction patterns, and root distribution under greenhouse conditions where examination of the entire root systems was possible could reveal effective and efficient means for irrigating alfalfa. 'Climmaron' alfale was planted in polyvniylchloride (PVC) containers (120 x 30 cm) filled uniformly with a Leeper fine (fine, montmorillonitic, nonacid, thermic Vertic Haplaquept) sandy loam top soil. Irrigation treatments included: watering to saturate the soil one-third of the whole root depth, watering to saturate the soil two-thirds of the whole root depth, and no irrigation. Irrigation was applied depth, and no irrigation. Irrigation was applied when available soild moisture content within the root zone reached 35% (-2.5 bars soil matric potential). The parameters studied included root distribuilon pattern, total root growth, water extraction pattern, and water use efficiency. The efficiency of water use was higher in deeply irrigated treatments than in shallow irrigated treatments than in shallow irrigated treatments during June and July (a period of high evapotranspirational demand), but it was not different during September

to November. Depth of irrigation did not affect total root production, but it did affect root distribution at the irrigation zone. Deeply irrigated plants produced slightly more roots in the lower depths than shallow irrigated plants. Root produc-tion of nonirrigated alfalfa was low under the high evaporational demand conditions which occurred evaporational demand conditions which occurred during June and July, but was highest among all treatments during the September to November growing period. Root-shoot ratios of 0.28, 0.22 and 0.62 observed in shallow, deep, and non-irrigated plants grown in the September to November period, respectively, indicate that the rate of root growth was increased in nonirrigated alfalfa as a result of limited water stress and under low evapo-transpirational demand. (Murphy-IVI) W84-03241

TILLAGE AND CULTURAL MANAGEMENT OF IRRIGATED POTATOES,

Iowa State Univ., Ames. Dept. of Agronomy. For primary bibliographic entry see Field 2G. W84-03242

WHEAT DEVELOPMENT AS AFFECTED BY DEFICIT, HIGH FREQUENCY SPRINKLER IRRIGATION,

Agricultural Research Service, Prosser, WA.

Agricultural Research Service, Prosser, WA.
A. N. Hang, and D. E. Miller.
Agronomy Journal, Vol. 75, No. 2, p 234-239,
March-April, 1983, 5 Fig. 4 Tab, 17 Ref. Washington State Univ. Coll. of Agriculture Research
Center project 0481.

Descriptors: \*Wheat, \*Water deficit, \*Sprinkler irrigation, Irrigation effects, Water stress, Plant growth, Soil types, Loam, Evpotranspiration.

An important limitation to wheat production worldwide is insufficient water. Therefore, it is important to know how the crop responds physio-logically to water stress. Variable irrigation treatnts were initiated at pre-or early-boot stage of ments were initiated at pre-or early-boot stage of Fielder spring and Nugaines winter wheat (Triticum aestivum L. em. Thell.) grown on sandy (mixed, mesic, Xeric Torripasamments) and loam (coarse-sity, mixed, mesic Xerollic Camborthids) soils. Different amounts of irrigation water were applied by the line source technique. Daily irrigation near the line source was equivalent to 1.00 (loam) or 1.15 (sand) times estimated evapotranspiration (ET). Pan evaporation (EP) estimated ET as ET = 0.95 EP. On sandy soil, stress symptoms as ET = 0.95 EP. On sandy soil, stress symptoms were first observed in plants receiving the least irrigation water (23% estimated ET) 2 weeks after treatments were initiated. Symptoms included decreased number of green leaves, shorter plants, fewer heads, increased specific leaf weight and increased leaf-stem dry weight ratios. Head growth rates were from 8.2 to 15.6 mg/head/day, growth rates were from 8.2 to 15.6 mg/head/day, at the lowest and highest applications, respectively. Reproductive growth rate, crop growth rate, and partitioning to reproductive growth increased with increased irrigation. Effects of decreased irrigation were less on loam soil than on sandy soil. Stress symptoms did not appear until late in the growing season. There were significant differences in plant height, total plant weight, and head weight between the plots receiving highest and lowest irrigation rates (100 vs. 20% estimated ET). Results indicate that normal growth and yield of wheat grown on sandy soil require irrigations that approach ET. However, on loam soil irrigation amounts can be decreased 40 to 50% without affecting developing of plant parts. (Murphy-IVI) W84-03243

IRRIGATION REGIME EFFECTS ON SOME PHYSIOLOGICAL RESPONSES OF POTATO,

Agricultural Research Organization (Israel). Gilat Regional Experiment Station. D. Shimshi, J. Shalhevet, and T. Meir. Agronomy Journal, Vol. 75, p. 262-267, March-April, 1983. 5 Fig. 3 Tab, 16 Ref.

Descriptors: \*Irrigation program, \*Irrigation effects, \*Physiological ecology, \*Potato, Water stress, Leaf permeability, Leaves, Evapotranspiration, Trickle irrigation, Plant water potential.

Potato is relatively sensitive to water stress, and therefore indices for characterizing the degree of water stress and its relation to tuber yield are sought. During a series of field irrigation experiments on potatoes (Solanum tuberosum L.) conducted on a calcic haploxeralf in the Negev region ducted on a calcic haploxeralf in the Negev region of Israel, data were collected on leaf permeability (LP), leaf and tuber water potential (psi sub l and psi sub t, respectively) and photosynthetic rate, with the aim of relating the variables to a range of water stresses caused by the ratio irrigation/evaporation (K sub p). Leaf permeability was linearly related psi sub l, which ranged from -0.7 kJ/kg in well irrigated plants to -1.4 kJ/kg in severely water-stressed plants. Tuber water potential, psi sub t, was higher by 0.4 to 0.7 kJ/kg than psi sub l, the difference increasing with water stress. the difference increasing with water stress. In trickle-irrigated plants psi sub l of tubers growing in dry soil was lower by 0.06 to 0.12 kJ/kg th in dry soil was lower by 0.06 to 0.12 kJ/kg than psi sub t of tubers growing in wet soil, even though the tubers were attached to the same stem. Photosynthesis increased with LP up to 0.8 mg CO2/sq m/sec and declined with plant age independently of LP. Marketable yield was well related to both easonal LP and psi sub !; all three variables decreased when K sub p dropped below 1.0. Leaf permeability seems to be a better index than leaf water potential for the characterization of water stress of potato in the field. (Author's abstract) W84.01344 W84-03244

FIELD EVALUATION OF A WATER RELA-TIONS MODEL FOR SOYBEAN. I. VALIDITY OF SOME BASIS ASSUMPTIONS,

B. Zur, J. W. Jones, and K. J. Boote. Agronomy Journal, Vol. 75, p 272-280, March-April, 1983. 6 Fig. 1 Tab, 17 Ref. USDA grant

Descriptors: \*Field tests, \*Model studies, \*Soy-bean, Water potentials, Stomatal transpiration, Moisture profiles, Drying.

Basic assumptions made in a model of stomatal feedback control, transpiration, and carbon dioxide exchange rate (CER) were tested on soybean (Glycine max L. Merr cv. Williams) grown in the field on an Arredondo fine sand soil. Intensive measurements were made of diurnal fluctuations in leaf water potential, stomatal resistance, transpiration water potential, stomatal resistance, transpiration rate (TR), and canopy CER during a drying cycle corresponding to the mid-to-late pod-filling period of the crop. A threshold leaf water potential initiaring stomatal closure at -1.6 MPa was measured in the field and verified the relationship assumed in the model. Linear relationships between transpiration rate and both radiation flux and vapor pressure deficit were found to exist only in well-watered plants having low stomatal resistances (1 to 3 tered plants having low stomatal resistances (1 to 3 sec/cm). Following the time when stomatal closure was initiated, the dependence of transpiration rate on climatic variables quickly dissipated. Transpiration rate on climatic variables quickly dissipated. spiration rate was independent of stomatal resistance for fully open stomata, quickly decreased following stomata closure and remained essentially constant at high stomatal resistance. This overall behavior was satisfactorily described by a modified Penman equation which includes a stomatal resistremnan equation which micrulies a stomata resistance term. A curvilinear relationship between CER and photosynthetically active radiation flux (PAR) existed as long as stomata were fully open. Following stomata closure, CER was independent of PAR above 500 microE/M2.sec (full sunlight 2,100 microE/m2.sec). The dependence of CER on stomatal resistance was similar to that of transpiration rate but with greater sensitivity. (Author's abstract) W84-03245

FIELD EVALUATION OF A WATER RELA-TIONS MODEL FOR SOYBEAN, II. DIURNAL FLUCTUATIONS,

Florida Univ., Gainesville. Dept. of Agricultural Engineering.
J. W. Jones, B. Zur, and K. J. Boote.

Agronomy Journal, Vol. 75, No. 2, p 281-286, March-April, 1983. 10 Fig, 7 Ref. DA grant 801-

#### Water In Plants-Group 21

Descriptors: \*Field tests, \*Model studies, \*Diurnal distribution, Water potentials, Plant water potential, Transpiration, Drying, Soil-water-plant relationships, Soil physical properties.

A field study was conducted on soybeans (Glycine max L. Merr. cv. Williams) growing in Arredondo fine sand, a member of the hypothermic, coated family of Typic Quartzipsamments to determine the effects of drying cycles on plant water relations for comparison with results predicted by a dynamic model. Two different drying cycle treatments were imposed on different plots during late vegetative development and mid-to-late pod fill stages and well irrigated plots were maintained for comparison. Every other day during each drying cycle, hourly measurements of leaf water potential, canopy carbon exchange rate (CER), and canopy transpiration were measured on dry and wet plots. canopy carbon exchange rate (CER), and canopy transpiration were measured on dry and wet plots. During the initial phases of the drying cycles leaf water potential, transpiration, and CER followed diurnal cycles closely related to radiation flux. This response lasted for 9 and 5 days during the This response lasted for 9 and 5 days during the first and second drying cycles, respectively, when crop water deficits reached critical levels causing leaf water potentials of -1.4 and -1.7 MPa. After these critical time periods, midday leaf water potentials became relatively stable with time whereas transpiration and CER decreased such that diurnal fluctuations disappeared. The model was successful in simulating diurnal patterns of these variables for the crop exposed to the two drying cycles. (Author's abstract) W84-03246

CROP YIELD - IRRIGATION RELATION-SHIPS IN A GYPSIFEROUS-SODIC SOIL, Agricultural Research Organization, Bet-Dagan (Israel). Div. of Soil Physics. For primary bibliographic entry see Field 3F. W84-03248

ALFALFA RESPONSES TO IRRIGATION TREATMENT AND ENVIRONMENT, Agricultural Research Service, Riverside, CA. Salinity Lab.
T. J. Donovan, and B. D. Meek.
Agronomy Journal, Vol. 75, p 461-464, May-June, 1983. 6 Fig, 1 Tab, 18 Ref.

Descriptors: \*Alfalfa, \*Irrigation effects, Irrigation requirements, Water management, Plant water potential, Crop yield, Evapotranspiration, Water use efficiency.

efficiency.

Water management is critical for maximum production of alfalfa (Medicago sativa L.) with under irrigation resulting in loss of production and over irrigation resulting in a loss of stand. To determine the optimum irrigation rates under high evaporative demand growth of alfalfa was evaluated on replicated plots (6 X 6 m) established on a fine textured soil (Typic Torrifluvent, clayey over loamy, montmorillonitic, calcareous hyperthermic family) and differentially irrigated from July 1975 to January 1978. The irrigation treatments were applied at 56, 66, 75 (best estimate of Et), and 84% of pan evaporation (Ep) and described as dry, semidry, optimum and wet, respectively. Alfalfa yields increased with increase in water applied. Irrigation at 84% Ep for leaching did not enhance yield over the optimum water treatment possibly because of reduced stand from waterlogging. The protein concentration of alfalfa was higher in dry than in wet treatments in March and November. During the summer, plant temperatures in the dry treatment were up to 7 C higher than in the wet treatment. (Murphy-IVI)

TURFGRASS GROWTH, N USE, AND WATER USE UNDER SOIL COMPACTION AND N FERTILIZATION, Kansas State Univ., Manhattan. Dept. of Horticul-

ture. M. J. Sills, and R. N. Carrow. Agronomy Journal, Vol. 75, p 488-492, May-June, 1983. 4 Tab, 22 Ref.

Descriptors: \*Plant growth, \*Nitorgen, \*Water use, \*Soil compaction, \*Fertilization, Water use \*Water

efficiency, Plant water potential, Environmental effects, Plant growth substances.

Soil compaction is a problem in many turf areas. Perennial ryegrass (Lolium perenne L. Pennfine') was subjected to two compaction treatments with an 11.5 kg falling weight: a) none and b) heavy-874 J energy. Two parts of fine, montmorillonitic mesic, Aquic Arguidoll soil (Chase silt loam) was used to one part medium silica sand by volume. Fertilization rate treatments were 0.5 and 1.0 kg used to one part medium silica sand by volume. Fertilization rate treatments were 0.5 and 1.0 kg N/100sq m. Nitrogen carrier treatments were water soluble N applied as NH4NO3 and water insoluble N applied as IBDU (isobutylidine diurea). Compaction increased bulk density, water retenion, and soil strength, while decreasing aeration porosity. Visual quality, clipping yield, N use per unit area of sod, evapotranspiration, and root growth declined with compaction. Verdure, total nonstructural carbohydrates (TNC), and percent N in leaf tissue were not affected by compaction. Initial TNC levels, water use efficiency, and N use per unit area, increased as N rate increased. Clipping yield, N use per unit area, and water use efficiency were higher with a water-soluble N carrier. Percent N in leaf tissue, early in the study, increased with water-insoluble fertilizer. The most detrimental effects of compaction were on root weight and distribution at the high N rate. Application of high N did not compensate for the adverse effects of compaction. (Murphy-IVI) W84-03250

WETTING AND MATURITY EFFECTS ON THE YIELD AND QUALITY OF LEGUME

Wisconsin Univ.-Madison. Dept. of Agronomy. M. Collins. Agronomy Journal, Vol. 75, p 523-527, May-June, 1983. 4 Tab, 16 Ref.

Descriptors: \*Wetting, \*Maturity, \*Crop yield, \*Legumes, Rainfall impact, Moisture stress, Moisture uptake, Alfalfa, Red clover, Dry matter.

Information is needed on the effects of rain on the magnitude of yield and quality losses of field cured legume hay. Three and one-half kilogram samples of alfalfa and red clover forage grown on Plano silt loam soil (fine-silty, mixed, mesic Typic Argiudoll) and harvested at early and late maturity stages were placed on wire screens and allowed to dry without wetting or were exposed to natural or were placed on wire screens and allowed to dry without wetting or were exposed to natural or artificial wetting in 1980 and 1981. A completely randomized design was used with three replications in 1980 and two in 1981. In 1980, 2.5 cm of water was applied to hay wetted during drying. In 1981, hay wetted during drying was exposed to 4.1 and 6.2 cm of precipitation, respectively. Mean dry matter (DM) losses during drying in 1980 were 8.1 and 17.0% from unwetted and wetted forage, respectively, but red clover harvested at the bud spectively, but red clover harvested at the bud stage and wetted lost 25.8% of the total DM. In stage and wetted loss 25.5% of the Chin Jest unwetted forage, forage wetted during drying and forage wetted after reaching 85% DM lost 10.5, 43.4, adn 53.0% of the initial DM. Wetting 10.5, 43.4, adn 53.0% of the initial DM. Wetting did, not change forage N concentration greatly in either year. Forage in vitro dry matter disappearance (IVDMD) was reduced by wetting in both years. In 1981 IVDMD was reduced from 66.4% for unwetted hay to 48.1% for hay wetted during drying. Mature forage of alfalfa was lower in IVDMD than bud stage alfalfa in both years regardless of wetting treatment. Neutral detergent fiber concentrations was increased by wetting red clover forage in both years. Prolonged wetting in fiber concentrations was increased by wetting red clover forage in both years. Prolonged wetting in 1981 reduced the yield of N and TNC by 40.3 and 71.5%, respectively. Dry matter and quality losses due to wetting of legume forage during hay curing vary with legume species and the timing and duration of wetting. Results indicate that plant constitution of wetting. Results indicate that plant constitutions of the plant was the first of their was reportibility. ents differ in their susceptibility to loss due to wetting during hay curing. (Murphy-IVI) W84-03253

INFLUENCE OF WATER STRESS ON THE DI-URNAL EXCHANGE OF MASS AND ENERGY BETWEEN THE ATMOSPHERE AND A SOY-BEAN CANOPY,

National Oceanic and Atmospheric Administra-tion, Oak Ridge, TN. Air Resources Atmospheric Turbulence and Diffusion Lab. D. D. Baldocchi, S. B. Verma, N. J. Ro L. Blad, and A. Garay.

L. Diad, and A. Caray. Agronomy Journal, Vol. 75, p 543-548, May-June, 1983. 6 Fig. 1 Tab, 40 Ref. Atmospheric Research Division, NSF grant ATM-7901017.

Descriptors: \*Water stress, \*Diurnal distribution, Mass, Energy, Atmospheric physics, Water use efficiency, Evapotranspiration, Micrometeorology, Carbon dioxide.

A micrometeorological-physiological study at Mead, Nebr., during the summer of 1980 examines the diurnal exchanges of mass and energy of well-watered and water-stressed soybean (Glycine max (L.) Merr. cy. Harosoy) canopies and relates these exchanges to environmental and physiological variables. Measurements of CO2, latent heat and sensible heat flux uses the Bowen-ratio energy balance technique. The soil of the area is a Sharpsburg silty clay loam (a fine, montmorillonitic, mesic Typic Argiudoll). Water stress greatly influenced the partitioning of available energy between latent and sensible heat flux. When the crop was well-watered, sensible heat (H) was directed toward the crop and caused latent heat exchange (LE) to exceed net radiation (Rn). When the crop was water stressed, only two-thirds of Rn was consumed as LE; the remainder was converted into sensible heat. Since both Rn and vapor pressure deficit were greater on the day when the crop into sensible heat. Since both Rn and vapor pressure deficit were greater on the day when the crop was water-stressed, stomatal closure appears to have been the primary cause of the reduction in LE. Carbon dioxide exchange was not sensitive to water stress in the morning but was severely limited by such stress during midday. The midday reduction in CO2 exchange appears to have been caused by a combination of high stomatal resistance limiting CO2 diffusion to the cell chloroplasts and low leaf water potential coupled with high air temperature affecting the enzymatic reactions associated with photosynthesis. Water use efficiency (defined in terms of the CO2-ewater flux ratio) was greater when the crop was well-watered than greater when the crop was well-watered than when it was stressed for water. A combination of water stress, a large vapor pressure deficit, and high air temperature reduced the CO2-water flux ratio. (Murphy-IVI) W84-03254

YIELD AND WATER USE EFFICIENCY OF GRAIN SORGHUM IN A LIMITED IRRIGA-TION-DRYLAND FARMING SYSTEM,

Agricultural Research Service, Bushland, TX. Conservation and Production Lab. B. A. Stewart, J. T. Musick, and D. A. Dusek. Agronomy Journal, Vol. 75, p 629-634, July-August, 1983. 4 Fig, 2 Tab, 13 Ref.

Descriptors: \*Water use efficiency, \*Water yield, \*Grain sorghum, \*Irrigation, \*Dry farming, Net rainfall, Transpiration, Evapotranspiration, Furrow dams, Water management, Soil-water-plant relationships.

A Limited Irrigation-Dryland (LID) farming system, for the conjunctive use of rainfall and limited irrigation of graded furrows, actually adjusts, during the crop growing season, the amount of land irrigated since more land can be irrigated during above-average rainfall years with a limited amount of irrigation water than during below-average years. The design used a limited water supply to irrigate a larger area than could be conventionally irrigated. A graded furrow field 600 m long on a 0.3 to 0.4% slope was divided into three water management sections. The upper half of the field was managed as 'fully irrigated.' The next one-fourth was managed as 'fully irrigated.' The next one-fourth was managed as a 'tailwater runoff' section that utilized furrow runoff from the fully irrigated section. The lower one-fourth was man irrigated section. The lower one-fourth was man-aged as a 'dryland' section capable of utilizing runoff from either rainfall or irrigation on the wetter sections. The system was field tested for 3 years with grain sorghum (Sorghum bicolor (L.) Moench) on a Pullman clay loam (fine, mixed, thermic family of Torretic Paleustolls). Seasonal rainfall values were 224 mm in 1979, 103 mm in

#### Group 21-Water In Plants

1980, and 424 mm in 1981 as compared to the average of about 250 mm. The LID system was successful in increasing the utilization efficiency of irrigation water. Irrigation water added to a field can be transpired, evaporated, percolated, lost as runoff, or left stored in the soil after harvest. The runoff, or left stored in the soil after harvest. The LID system tended to reduce all losses other than transpiration. When 125 mm or 185 mm of irrigation water were added with the LID system, the evapotranspiration by grain sorghum was increased by an almost equal amount. This increased grain yield an average of 154 kg/ha for each 10 mm added irrigation, compared to 92 kg/ha for each 10 mm under conventional irrigation practices (Murphy-IVI) W84-03258

NITROGEN FIXING ACTIVITY OF WATER STRESSED STRATRO, Texas A and M Univ., College Station. Dept. of Range Science.
M. Ismaili, D. D. Briske, and R. W. Weaver.
Agronomy Journal, Vol. 75, p 649-653, July-August, 1983. 4 Fig. 12 Ref.

Descriptors: \*Nitrogen fixing, \*Water stress, \*Siratro, Water potentials, Drought, Soil water potential, Plant water potential, Nitrogen, Soil-water-plant relationships, Leaves.

Siratro 'Macroptilium atropurpureum (DC.)
Urb.cv.siratro' is grown in tropical and subtropical
environments characterized by frequent periods of
drought and is dependent on N2 fixation for its N.
Leaf and nodule water potentials to N2 (C2H2)
fixing activity and the capability of nodules to
recover N2 (C2H2) fixing activity forty-two days
ofter planting four water treatments were impacting. after planting four water treatments were imposed by withholding water for increasing periods of time. This created a decrease in leaf and nodule water potentials corresponding to the period of time water was withheld. However, when water potentials decreased below -1.5 MPa, nodule water rotentials become more weative than leaf water potentials decreased below -1.5 MPa, nodule water potentials became more negative than leaf water potentials. A similar decrease in water potential suppressed growth of both nodules and shoots. In the longer duration, water withholding treatments nodule and shoot weights decreased as a result of nodule sloughing and leaf shedding. All water withholding treatments reduced the rate of N2 (C2H2) fixing activity. Nodules with water potentials of -1.5 MPa or greater were able to regain much of their N2 (C2H2) fixing activity within 2 d following rewatering. The specific activity of nod-following rewatering. The specific activity of nodfollowing rewatering. The specific activity of nod-ules surviving the most severe level of water stress ules surviving the most severe level of water stress (-1.9 MPa) were only about 60% as active as the control 6 d following rewatering. Nodules were control of a following rewatering. Nodules were irreversibly inactivated by water stress more severe than -3.0 MPa but in approximately 12 d following rewatering new nodules developed. Regrowth of siratro following water stress may be delayed while the capacity for N2 fixation recovers. (Murphy-IVI) W84-03259

4

EFFECTS OF IRRIGATION ON ACCUMULA-TION OF SOIL AND SYMBIOTICALLY FIXED N BY SOYBEAN GROWN ON A NORFOLK LOAMY SAND,

Agricultural Research Service, Florence, SC. Coastal Plains Soil and Water Conservation Re-

September-October, 1983. 1 Fig. 4 Tab, 16 Ref.

Descriptors: \*Irrigations effects, \*Nitrogen, \*Accumulation, \*Soil, \*Soybean, \*Loamy sand, Drought, Water management, Nitrogen fixation, Comparison studies.

stern Coastal Plain, soybean (Gly-In the southeastern Coastal Plain, soybean (Giycine max (L.) Merr.) is normally grown on soils that are often exposed to drought and leaching rains as well as being low in available N. This field study evaluates the impact of water management on accumulation of soil and symbiotically fixed N by soybean grown on these type soils. Nodulating and nonnodulating isolines of 'Lee' cultivar soybean were grown under irrigated and nonirrigated and point in 1970 and 1980 on a Norfolk loamy. bean were grown under irrigated and nonirrigated conditions in 1979 and 1980 on a Norfolk loamy

sand (fine-loamy, mixed, mesic Typic Paleudults). A period of excessive rainfall occurred in 1979, while a major drought occurred in 1980. Irrigated treatments had lower soil-NO3(-) concentrations in the Ap horizon than nonirrigated treatments during 1979, but there was no effect of irrigation on soil NO3(-) in 1980. Dinitrogone fixation, as estimated by the difference in N accumulation between nodulating and nonnodulating isolines, accounted for 76 to 91% of total plant N in the irrigated plots and 55 to 60% in the nonirrigated plots. Total plant N fixed exceeded 1100 mg/plant for the irrigated plots in 1979 and 1980. Maximum N accumulation for the nodulating isoline occurred in the nonirrigated plots in 1979 and in the irrigated plots in 1979 and in the irrigated plots in 1979 and in the irrigated plots in 1980 and in the irrigated plots during the nonirrigated plots in 1980. The number of nodules/plant and the C2H2(-) reducing activity were significantly ligher in the irrigated plots during the pod growth siages in 1980. Irrigation did not significantly affect seed yield of nodulating Lee soybean in 1979, but did result in a twofold increase in 1980. The effects of irrigation on the Lee nonnodulating soline resulted in a positive yield response in 1980. 1979, but did result in a twofold increase in 1980. The effects of irrigation on the Lee nonnodulating isoline resulted in a positive yield response in 1980, but a negative response in 1979. These findings show that a major portion of the N-requirement for soybean in the southeastern Coastal Plain is met by fixation and that the relative importance of fixed N may vary substantially with rainfall patterns and irrigation. (Murphy-IVI) W84-03260

SOIL WATER AND POPULATION INFLU-ENCE ON HYBRID SUNFLOWER YIELD AND UNIFORMITY OF STAND, North Dakota State Univ., Fargo. Dept. of Soil

Agronomy Journal, Vol. 75, p 745-749, September-October, 1983. 3 Fig. 3 Tab, 24 Ref.

Descriptors: \*Soil water, \*Population, \*Sunflower, \*Yield, \*Stem, Soil water potential, comparison studies, Irrigation effects.

Sunflower (Helianthus annuus L.) hybrids do not respond identically to agronomic and environmen-tal variables. The present study quantifies the influ-ence of soil water potential and plant population ence of soil water potential and plant population on oilseed sunflower hybrids 'Dahlgren 704', USDA 894', and 'Interstate 907'. Desire to refind 'USDA 894', and 'Interstate 907'. Desire to refind knowledge of yield relationships was one motivation for the study, but a deeper stimulus was the need for basic knowledge of the detailed nature of sunflower stands. One plot site had Maddock (sandy, mixed Udorthentic Haploboroll) and Gardna (coarse-sitty, mixed pachic Udic Haploboroll) soils. This location received irrigation treatments limiting soil water potentials to minimums of .35. cena (coarse-sitty, mixed pacinic Udic Haploboroll) soils. This location received irrigation treatments limiting soil water potentials to minimums of -35, -70, and -105 J/kg. The second site had Bearden (fine-silty, frigid Aeric Calciaquoll) soil and was not irrigated. Yield increased with soil water potential from 201 g/sq m at -105 J/kg to 284 g/sq m at -35 J/kg. Dryland yields were 200, 179, and 164 g/sq m for hybrids 894, 704, and 907. Population did not influence yields. However, irrigated and nonirrigated stand loss percentages increased with population at 0.8 and 2.2% per plant per square meter, respectively. Knowledge of the threshold population for stand loss provides a rationale for selection of population in the absence of yield differences because significant stand loss indicates a possibly undesirable level of intraspecific competition. Guidelines for irrigation scheduling for sunflower by use of tensiometers are now on a sounder experimental basis. Hybrids similar under irrigation yielded differently under dryland conditions. (Murphy-IVI) W84-03261 (Murphy-IVI) W84-03261

RESPONSE OF DRY BEANS TO DAILY DEFI-CIT SPRINKLER IRRIGATION. Agricultural Research Service, Prosser, WA. For primary bibliographic entry see Field 3F. W84-03262

ALFALFA STEM AND LEAF GROWTH DURING WATER STRESS,

Wisconsin Univ.-Madison. Dept. of Soil Science. P. W. Brown, and C. B. Tanner. Agronomy Journal, Vol. 75, p 799-805, July-August, 1983. 6 Fig. 1 Tab, 22 Ref. ARS project 142-1710.

Descriptors: \*Alfalfa, \*Leaf growth, \*Water Stress, Irrigation effects, Leaves, Water potential, Stomata, Soil-water-plant relationships.

Alfalfa (Medicago sativa L.) requires irrigation in semiarid and arid regions and improved yields often result from irrigation in subhumid and humid often result from irrigation in subhumid and humid areas. Despite the importance of optimizing water management for alfalfa leaf and stem growth, no field study has been reported which relates alfalfa leaf expansion or stem extension to plant water deficits. How does leaf expansion, stem elongation, and stomatal response of alfalfa relate to the water potential in alfalfa, field-grown on Plainfield loamy sand (mixed, mesic Typic Udipsamment). Periodic measurements of alfalfa stem extension and leaf expansion (area derived from length and width measurements) were related to leaf water potential (psi L) measured with a pressure chamber, soil matric potential (psi m, measured with tensioneters, and stomatal conductance measured with porometers. For wellwatered alfalfa, expansion curves of individual leaves were sigmoid-shaped, while internode extensions were nearly exponential with time through about 95% of the total extension. The primary leaf attached at the top of an internode a standard conductance and internode extensions to the total extension. with time through about 95% of the total extension. The primary leaf attached at the top of an internode expands to nearly full size before the internode begins rapid extension. The growth of individual leaves and internodes collectively results in nearly constant rates of leaf expansion and stem extension during vegetative regrowth. When psi m at 30 cm decreased to -0.35 bar, afternoon psi L decreased to about -8 bars, about 2 bars below irrigated alfalfa, and both the growth rate (GR) and relative growth rate (RGR) of stressed leaves and stems were significantly less (p < 0.1) than well-watered leaves and stems. In stressed treatments, willing, grav-green canony color, decreased well-watered leaves and stems. In stressed treatments, wilting, gray-green canopy color, decreased afternoon stomatal conductance, and a 50% decrease in RGR as compared to irrigated treatments resulted when afternoon psi L decreased to about 15 bars even though psi m exceeded -0.1 bar at 90 and 150 cm. Alfalfa extracted 85% of its total water from the 1st meter of soil prior to the onset of decreased afternoon stomatal conductance, but of decreased afternoon stomatal conductance, but nearly equal percentages from each of the top 2 m of soil afterward. Little shoot growth occurred when psi L dropped below -10 bars. Development of water stress 2 weeks after cutting reduced afalfaleaf size, internode length, and dry matter production, but not leaf and internode number or stem density. The percentage of total forage dry weight in leaves (LPDW) decreased linearly with stem height resulting in higher LPDW and a better quality forage in stressstunted forage. Cool night temperatures limited growth of well-waterd alfalfa. (Murphy-IVI) W84-03263

EFFECT OF WIND ON THE CROP WATER STRESS INDEX DERIVED BY INFRARED THERMOMETRY,

California Univ., Davis J. C. O'Toole, and J. L. Hatfield. Agronomy Journal, Vol. 75, p 811-817, September-October, 1983. 6 Fig, 1 Tab, 13 Ref.

Descriptors: \*Water stress, \*Wind pressure, \*Infra-red Thermometry, \*Temperature, Plant water po-tential, Canopy, Sorghum, Cotton, Micrometeoro-

A new plant or crop water stress index (CWSI) that depends on interpreting crop or foliage-to-air temperature differential (Tf-Ta) shows promise in both research and irrigation water management. The method relies on the unique relation between Tf-Ta and atmospheric water vapor pressure defi-cit (VPD). However, the method of estimating the cit (VPD). However, the method of estimating inc upper limit of Tf-Ta, a critical step in CWSI calculation, was questionable and lacked field validation. The upper limit of Tf-Ta and attendant micrometeorological variables on severely water stressed sorghum (Sorghum bicolor L.), corn (Zea mays L.), and bean (Phaseolus vulgaris L.) grown

#### Water in Plants-Group 21

on a Typic Xerotherent, and cotton (Gossypium hirsutum L.) grown on a Typic Torriorthent ranged from 2.5 to 8.5C across crops. There was poor agreement between actual and calculated values with respect to net radiation, VPD, and windspeed. Windspeed was found to be the property of the contraction mary factor causing erroneous estimation of the upper limit of Tf-Ta and hence CWSI values. Crop upper limit of Tf-Ta and hence CWSI values. Crop water stress index values measured at low wind-speed overestimated the level of water stress while those measured at high windspeed underestimated it. Crop specific changes in the boundary layer resistance-windspeed relationship partially explain the discrepancy between measured and calculated Tf-Ta upper limit values. Modification of the CWSI to account for the influence of windspeed is discussed. (Murphy-IVI) W84-03265

A METHOD FOR INDUCING CONTROLLED MOISTURE STRESS ON SEEDLINGS, North Carolina State Univ. at Raleigh. Dept. of

Crop Science. M. Sikurajapathy, J. J. Cappy, and H. D. Gross. Agronomy Journal, Vol. 75, p 840-843, September-October, 1983. 2 Fig. 3 Tab, 17 Ref. Agency for International Development grant AID/csd 2835.

Descriptors: \*Moisture stress, \*Seedlings, Soil water, Soil water potential, Soil columns, Water potential, Drought, Rice, Mungbean.

Selectively permeable sleeves filled with soil were held in tanks containing various polyethylene gylcol (PEG) 10 000 solutions in order to evaluate neld in tanks containing various polyetnylene gylcol (PEG) 10 000 solutions in order to evaluate seedling tolerance to soil moisture stress. The soil columns, made of 7.6 cm diam dialysis tubing (molecular weight (MW) cut off 8000), were fitted to plexifalsa bases and placed in tanks containing PEC 10 000 solutions calibrated to provide the desired soil water potentials (-0.01, -0.1, -0.5, and -1.5 MPa). The columns contained 2.5 kg soil. The membrane maintained its integrity over a 30-day period. Soil water moved in response to gradients created by the osmoticum; the small pore size of the permeable sleeves prohibited the PEG from entering the soil. Water loss measured for soil columns immersed in PEG solution maintaining -0.01 MPa potential revealed no movement in either direction. At -0.5 MPa, water moved gradually out of the soil cocurred within 20 h, leading to a loss of 60% of the water in the columns. Water content at various column depths after 12 and 30 days immersion at the different potentials were every uniform. sion at the different potentials were very uniform. No detectable amounts of PEG were found in roots, shoots, or leaves of mungbean (Vigna radiata (L.) Wilczek) or rice (Oryza sativa L.). The technique makes possible precise control of water-stress intensity (water potential), water-stress du-ration, and recovery from water stress. (Author's abstract) W84-03267

YIELD AND WATER RELATIONS OF PEARL MILLET GENOTYPES UNDER IRRIGATED AND NONIRRIGATED CONDITIONS, International Crops Research Inst. for the Semi-Arid Tropics, Patancheru (India).
P. Singh, E. T. Kanemasu, and P. Singh. Agronomy Journal, Vol. 75, p 886-890, November-December, 1983. 1 Fig, 8 Tab, 19 Ref.

Descriptors: \*Crop yield, \*Water stress, \*Pearl millet, \*Irrigation effects, Drought, Plant water potential, Leaves, Water use.

Drought resistance in pearl millet (Pennisetum americanum (L.) Leeke) makes it an important food crop in arid and semiarid regions, but refood crop in arid and semiand regions, but re-search is limited on drought resistance and physio-logical responses to water stress. To study the relationship of pearl millet yield to physiological characteristics, 10 pearl millet genotypes were grown under irrigated and nonirrigated conditions on a sitt loam soil (fine-sitty, mixed mesic, Pachic Haplustoll). Leaf diffusion resistance of adaxial (LDRad) and abaxial (LDRab) surfaces, leaf water potential (psi L), leaf osmotic potential (psi pi L) and stem osmotic potential (psi pi s) of genotypes

were recorded in both treatments in the afternoon (1200 to 1700 h) when the crop was water-stressed. Leaf diffusion resistance (LDR) for a leaf was calculated as LDR = (LDRad x LDRab) (LDRad + LDRab). LDRad, LDRab, LDR, psi L, psi pi L, and psi pi s observed for each genotype were averaged over the stress period and correlated with yields and yield ratios (nonirrigated yield) of genotypes. Majority of genotypes tudies did not differ significantly (P < 0.05) in average afternoon LDRab, psi L, psi pi L, psi pi s, and water use (WU) in both the treatments except that genotypic differences were significant in average afternoon LDRad and LDR in the nonirrigated treatment. Grain yield was significantly correlated with LDRab in both irrigated (r = 0.79) and nonirrigated (r = 0.72) treatments, suggesting that high LDRab of genotypes is associated with low grain yield. Grain yield ratio was significantly correlated with LDRab (r = 0.71) and LDR (r = 0.66) in the irrigated treatment and with psi L (r = 0.64) and psi pi s (r = 0.78) in the nonirrigated treatment. Average afternoon psi L did not correlate with grain yield or grain yield ratio. It is concluded that average afternoon LDRab could be used to rank pearl millet genotypes for their grain yield in both stressed and nonstressed environment. (Author's abstract)

RELATIONSHIPS BETWEEN LEAF WATER POTENTIAL, CANOPY TEMPERATURE, AND EVAPOTRANSPIRATION IN IRRIGATED AND NONIRRIGATED ALFALFA, Minnesota Univ., St. Paul. For primary bibliographic entry see Field 2D. W84-03270

MAGNESIUM NUTRITION AND GRAIN YIELD OF MAIZE HAVING LOW WATER PO-

TENTIAL, Navarra Univ., Pamplona (Spain). Dept. Fisiologia

Vegetal.
P. M. Aparicio-Tejo, and J. S. Boyer.
Agronomy Journal, Vol. 75, p 919-923, November-December, 1983. 5 Fig, 4 Tab, 18 Ref. NSF grant PCM 79-09790.

Descriptors: \*Magnesium, \*Maize yield, \*Plant water potential, Plant growth substances, Leaves.

Drought decreases plant production but the nutritional status of the plants may alter their susceptibility. Losses in the activity of chloroplast coubility. Losses in the activity of chloroplast coupling factor could be simulated by concerntrations
of Mg slightly higher than those usually present in
chloroplasts. Since dehydration might increase cellular ion concentrations, it is possible that the
photosynthetic response of plants to low water
potentials would reflect at least in part the ion
status of the tissues. Plants were grown at two soil
Mg levels in a controlled environment capable of
providing yields comparable to those in the field.
The grain yield, shoot and root dry weight, leaf
water potential (psi w) and tissue mineral composition were determined. Immediately after tasseling,
water was withheld from the soil of half the plants
until the psi w had decreased to -1.8 to -2.0 MPa,
where it remained until maturity. Low water potentials resulted in a 50% reduction in grain yield
and an accelerated leaf senescence. Despite small
but significant differences in Mg concentration in
roots, stems, and leaves, no differences attributable roots, stems, and leaves, no differences attributable to differences in Mg nutrition were found in rate of plant dehydration, dry matter accumulation, or grain yield. Differences in Mg content of the plant either do not influence response to low psi w, or must be larger than achieved to see an effect. (Murphy-IVI) W84-03272

SOYBEAN WATER STATUS AND CANOPY MICROCLIMATE RELATIONSHIPS AT FOUR

ROW SPACINGS,
Agricultural Research Service, Florence, SC.
Coastal Plains Soil and Water Conservation Research Center.

search Center. R. E. Sojka, and J. E. Parsons. Agronomy Journal, Vol. 75, p 962-968, November-December, 1983. 7 Fig, 1 Tab, 32 Ref.

Descriptors: \*Soybeans, \*Plant water potential, \*Canopy, \*Microclimate, \*Cultivation, Humidity, Temperature, Moisture availability, Evapotranspir-

There is little field data relating plant water status and canopy microclimate of determinate soybean 'Glycine max (L.) Merr.' cultivars grown in humid environments. Also, few observations of these parameters have been reported for the period prior to complete canopy closure. A field study in South Carolina in 1979 determines these basic relationcomplete canopy closure. A field study in South Carolina in 1979 determines these basic relationships for two determinate soybean cultivars, Davis (Group VII) and Coker 338 (Group VIII) grown in 1,02, 0,76, 0,51 and 0,36-m row spacings. The experiments were conducted on a Norfolk loamy sand (fine-loamy, siliceous, thermic, Typic Paleudult). Thermistor-determined leaf temperatures (T sub L) and ambient temperatures (T sub A) were highly correlated, and no significant improvement in the correlation resulted from treating row spacing or diurnal periods separately. Both T sub L and delta T(T sub L - T sub A) were highly correlated with pressure chamber determination of xylem pressure potential (psi x). Parallel leaf diffusive resistance (Rs) was not highly correlated with any of the canopy microclimate or water status parameters observed. Atmospheric vapor pressure deficit (LVPD). No row spacing effect on psi x was observed, but mean seasonal midday psi x, was 0.10 MPa lower for Coker 338 than for Davis (P < or = to 0.001) and osmotic potential was 0.20 MPa lower for Coker 338 than for Davis (P < or = to 0.001). The authors propose that the slope of delta T vs. VPD may be influenced by high prevailing relative humidity and heating of the canopy from exposed soil between rows in the period prior to complete canopy coverage. (Murphy-IVI)

ROOT SYSTEM CHARACTERISTICS OF TWO SOYBEAN ISOLINES UNDERGOING WATER

SOYBEAN ISOLINES UNDERGOING WATER STRESS CONDITIONS,
Nebraska Univ.-Lincoln. Center for Agricultural Meteorology and Climatology.
A. F. Garay, and W. W. Wilhelm.
Agronomy Journal, Vol. 75, p 973-977, November-December, 1983. 2 Fig, 4 Tab, 15 Ref.

Descriptors: \*Roots, \*Soybeans, \*Isolines, \*Water stress, Root development, Moisture uptake, Root distribution, Moisture availability.

Environmental stress may have a differential influence on root development of soybean 'Glycine max (L.) Merr.' isolines which vary in pubescence max (L.) Merr.' isolines which vary in pubescence density. Root length density and root dry matter distribution as a function of depth and distance from the row were determined for two isolines of 'Harosoy' soybean in association with an experiment designed to evaluate the influence of epidermal pubescence on root development, water use, and photosynthetic characteristics of the two isolines. The isolines the recovery normal (HN) and Hos and photosynthetic characteristics of the two iso-lines. The isolines, Harosoy normal (HN) and Har-soy dense (HD), differed in the density of tri-chomes on the epidermal surfaces of leaves, stems, and pods. Root samplings were collected 47 (full bloom) and 78 (beginning seed) days after planting. Until the first sampling, soil water content was high at all depths, and roots were concentrated in the surface 0.15-m layer, especially under the row. Eighty percent of the roots were found within the upper 0.30 m. By 78 days after planting and after 30 days of drought, root length density was great-est at the 0.90 to 1.20-m layer, 80% of the roots were found within the 0 root 1.2-m layer; and uniform lateral distribution was observed. Harosoy dense pubescence isoline tended to have a greater root density, to explore deeper into the soil, and to extract more soil water during the drought than did the normal pubescence isoline. However, the rate of water extraction (per unit root length) was greater for the HN isoline. (Murphy-IVI) greater for W84-03274

MOISTURE STRESS AND N REDISTRIBU-TION IN SOVBEAN.

#### Field 2—WATER CYCLE

#### Group 21-Water In Plants

Kentucky Agricultural Experiment Station, Lexington. Dept. of Agronomy.
D. B. Egli, L. Meckel, R. E. Phillips, D. Radcliffe, and J. E. Leggett.
Agronomy Journal, Vol. 75, p 1027-1031, November-December, 1983. 1 Fig. 4 Tab, 21 Ref.

Descriptors: \*Moisture stress, \*Nitrogen, \*Distribution, \*Soybean yield, Irrigation effects, Trickle irrigation, Nitrogen fixation.

The redistribution of N from vegetative plant parts The redistribution of N from vegetative plant parts to the developing seed of soybean 'Glycine max (L.) Merr.' may influence the duration of seed filling and yield. The objective of this study was to investigate the effect of moisture stress during various developmental stages on N redistribution. Soybean (cv. Williams) was grown in the field at Lexington, Ky., for 3 years (1979 to 1981) on a Maury silt loam (fine, mixed, mesic Typic Paleullo and Irrigated controls was compared with Maury silt loam (fine, mixed, mesic Typic Paleu-dalf) soil. Irrigated controls were compared with moisture stress treatments from planting to begin-ning seed fill (growth stage RS), during seed filling (growth stage RS to R7) or throughout the grow-ing season. Stress was applied by not irrigating until the soil water potential reached -3001/kg or by covering the soil with black plastic after emer-gence to allow severe stress to develop. Plant weight at growth stage RS and yield were affected by the moisture stress treatments, however, moisby the moisture stress treatments, however, mois ture stress had only a limited effect on N concentration in the plant tissue. The proportion of seed N that came from redistribution varied among treatments and years from 33 to 102% with no treatments and years from 33 to 102% with no consistent relationship between the level or timing of moisture stress and the contribution of redistributed N to seed N. The proportion of the N in the vegetative plant and pod walls that was redistributive. vegetante paint and pour waste that was treatments and years. The contribution that redistributed N makes to the seed N at maturity is more closely related to the amount of N available for redistribution than it is to ability of plants to obtain N from the soil or via N2 fixation during seed filling. (Murphy-IVI)

COMPARATIVE PHYSIOLOGY AND WATER RELATIONS OF TWO CORN HYBRIDS DURING WATER STRESS, Du Pont de Nemours (E.I.) and Co., Wilmington, DE. Central Research and Development Dept.

R. C. Ackerson.
Crop Science, Vol. 23, No. 2, p 278-283, March-April, 1983. 8 Fig, 26 Ref.

Descriptors: \*Corn, \*Plant physiology, \*Water stress, Plant water potential, Leaves, Drought, Water conveyance.

Water stress usually reduces crop growth and productivity. Although several important physiological processes can be dramatically altered by water stress, it is uncertain which processes are important with respect to adaptation, acclimation tolerance or resistance to drought. One hybrid (XL62AA) was a good drought tolerant commercial hybrid, while the other was an experimental hybrid (LH) derived from a cross of two Latente parents. The hybrids were compared to assess their relative responses to water stress. The LH hybrid exhibited higher rates of leaf photosynthesis than the Water stress usually reduces crop growth and pro responses to water stress. The LH hybrid exhibited higher rates of leaf photosynthesis than the XL62AA hybrid, but only a high leaf water potentials. Photosynthetic rates of both hybrids decreased as leaves aged. The LH hybrid maintained higher levels of soluble sugars and starch in the leaves as water potentials declined, perhaps owing to higher photosynthetic. The concentration of abscisic acid was also higher in the LH hybrid particularly when plants became water stressed. Comparisons of the internal water relations between the hybrids indicated that differences in the leaf turgor-leaf water potential relationship existed tween the hybrids indicated that differences in the leaf turgor-leaf water potential relationship existed only during the time tassels were emerging. During this period, the LH hybrid maintained higher turgor pressures at all leaf water potentials compared with the XL62AA hybrid. When stress was imposed during the time of rapid leaf expansion and the mid-grain filling stages of development, the leaf turgor-leaf water potential relationships were similar in the two hybrids. The LH hybrid exhibited certain physiological characteristics that may allow greater drought tolerance or

resistance when compared with a good drought tolerant commercial hybrid. As such, the LH hybrid may represent an important source of germ-plasm for developing more drought tolerant hy-brids. (Murphy-IVI) W84-03276

YIELD, WATER RELATIONS, GAS EX-CHANGE, AND SURFACE REFLECTANCES OF NEAR-ISOGENIC WHEAT LINES DIFFER-ING IN GLAUCOUSNESS, Agricultural Research Service, Logan, UT. Crops

such Lah D. A. Johnson, R. A. Richards, and N. C. Turner. Crop Science, Vol. 23, No. 2, p 318-325, March-April, 1983. 4 Fig, 5 Tab, 21 Ref.

Descriptors: \*Crop yield, \*Plant water potential, \*Reflectance, \*Wheat, \*Glaucous, Soil water po-tential, Water use efficiency, Epicuticular wax, Transpiration, Leaves, Drought resistance.

Near-isogenic lines that contrast in the presence or absence of glaucousness were developed in durum wheat (Triticum turgidum L. durum group) and common wheat (T. aestivum L.) and grown in plots in three field environments varying in soil water availability. The glaucous selections yielded water availability. The graucous selections yielded significantly more grain and dry matter than non-glaucous selections in the two higher yielding environments but not in the very dry environment where average yield was 66 g/sq m. No differences within or between lines were found in soil water extraction patterns. Furthermore, leaf water potentials determined at predawn and middley exhibited tials determined at predawn and midday exhibited no consistent differences between glaucous and non-glaucous selections. Lines selected for glaucousness varied in wax content of the different plant parts. Although differing in glaucousness, the glaucous selections did not necessarily exhibit greater amounts of epicuticular wax. Field gas exchange measurements for flag leaves and sheaths also indicated no beneficial or detrimental effects also indicated no beneficial or detrimental effects of glaucousness at saturating light and optimum temperature for photosynthesis. Surface reflectances in the 400 to 700 nm wavelengths were the same for the adaxial surface of the flag leaf, but were 8 to 15% higher in the glaucous than nonglaucous selections of one line for the ear, sheath, and abaxial flag leaf surface. Reflectances increased linearly with amount of epicuticular wax and were greater in the driest environment. The greater yield of the glaucous over the non-glaucous lines is discussed in relation to differences in reflectance and the possible influence of glaucousreflectance and the possible influence of glaucous-ness on tissue temperature, leaf area duration, and other factors. (Author's abstract) W84-03277

GENOTYPIC VARIATION FOR GLYCINEBE-TAINE ACCUMULATION BY CULTIVATED AND WILD BARLEY IN RELATION TO WATER STRESS, Shell Development Co., Modesto, CA. J. A. R. Ladyman, K. M. Ditz, R. Grumet, and A.

Crop Science, Vol. 23, No. 3, p 465-468, May-June, 1983. 1 Fig, 4 Tab, 19 Ref. Dept. of Energy contract DE-AC02-76-ERO1338.

Descriptors: \*Glycinebetaine, \*Accumulation, \*Cultivation, \*Barley, \*Water stress, Drought resistance, Betaine.

The accumulation of betaine (glycinebetaine, N,N,N-trimethylgly-cine) in barley (Hordeum vulgare L.) during water stress may be of adaptive value. The objective of this research was to evaluate the variability for betaine level among genotypes of H. vulgare and H. spontaneum C. Koch in preparation for a physiological-genetic assessment of the adaptive value of betaine accummulation. Betaine was determined using either a pyrolysis/gas chromatographic method or a periodide spectrophotometric assay, specially modified for screening. In controlled environment tests, 339 genotypes were grown to the four-leaf stage under well-watered conditions and analyzed for shoot betaine level; 145 of these were also tested under water-stressed conditions. There were significant differences for betaine level among genotypes,

both without and with water stress (approximate ranges of betaine levels: 10 to 40 micromol/g dry wt in well-watered conditions; 35 to 90 micromol/g dry wt under stress). The betaine levels of stressed plants were significantly correlated with those of unstressed plants of the same genotype. those of unsuressee plants of the same garderype. Thirteen H. vulgare cultivars which were high and low accumulators in controlled environments were grown in the field under simulated dryland conditions and betaine was analyzed in the upper leaves. At the ear emergence stage, significant variation for betaine level was observed among cultivars although there were no significant differences in their water status. Those cultivars that accumulated either high or low levels of betaine in controlled ed either high or low levels of betame in controlled environments accumulated respectively high or low levels in the field, the correlation among culti-vars in the two environments was highly signifi-cant (r = 0.71). These results indicate that genoty-pic variability for betaine level is expressed in both controlled environmental and in the field, and that this variability is unlikely to be due solely to varia-bility for the state. Beneficially experienced by setting tins variations; is unificely to be due solve to varia-bility for water status. Physiological-genetic stud-ies of the adaptive role of betaine may thus be possible. (Author's abstract) W84-03278

IRRIGATION OF SOYBEAN GENOTYPES DURING REPRODUCTIVE ONTOGENY. I. AGRONOMIC RESPONSES,

Nebraska Univ.-Lincoln. Dept. of Agronomy. L. L. Korte, J. H. Williams, J. E. Specht, and R. C.

Crop Science, Vol. 23, No. 3, p 521-527, May-June, 1983. 4 Fig. 1 Tab, 37 Ref. Nebr. Agric. Exp. Stn. projects 12-012 and 12-091.

Descriptors: \*Irrigation, \*Soybeans, Soil moisture, Water stress, Cultivars, Seed yield, Irrigation management, Irrigation effects.

Successful irrigation management for soybeans 'Glycine max (L.) Merr.' requires a knowledge of the effect of irrigations applied during specific stages of reproductive ontogeny. Eight soybean cultivars, varying in stem growth habit and maturi-ty, were subjected to a factorial set of eight irrigaty, were subjected to a factorial set of eight irriga-tion treatments involving either no irrigation or one irrigation applied at three reproductive stages: R1 to R2 flowering (F), R3 to R5 pod elongation (P), or R5 to R6 seed enlargement (S). The experi-ment was conducted for 3 years on a Sharpsburg silty clay loam (Typic Argiudoll). An F irrigation had little effect on ultimate seed yield (+ 20 kg/ ba) and for some cultivars actually depressed yield ha) and for some cultivars actually depressed yield below that of the nonirrigated check. A P irriga-tion consistently increased seed yield (+379 kg/ ha), irrespective of cultivar or year. An S irrigation also enchanced seed yield (+384 kg/ha), but the also enchanced seed yield (+384 kg/ha), but the degree of enhancement was inconsistent across years, being influenced by the amount of natural rainfall occurring during the seed enlargement stage. Although a dual F-P irrigation treatment enhanced seed yield above that for both the nonirrigated check and single F irrigation treatment, the emaniced seed yield anove final for both the nonirrigated check and single F irrigation treatment, the seed yield increase was significantly smaller (+166 kg/ha) than that achieved with a single P irrigation treatment. Soybean maturity was delayed 2 to 6 days with irrigation but the delay was greatest when irrigation was applied late in reproductive ontogeny. This senescence delay lengthened the seed-fill period and was responsible in part for the seed yield enhancement effected by irrigation. Increases in soybean plant height and lodging were greatest with an F irrigation, intermediate with a P irrigation, and minimal with an S irrigation. Although irrigation effects on seed quality were variable depending on the cultivar, there was an overall tendency for a P irrigation to improve and an S irrigation to worsen seed quality. An F irrigation had no effect on seed quality. Of the eight cultivars evaluated, the determinate 'Elf' was the most yield responsive to irrigation and was relatively resistant to changes induced by irrigation in plant height, lodging, and seed quality. Based on these data, portional visid senheroment in irrigation ded. lodging, and seed quality. Based on these data, optimal yield enhancement in irrigated soybean culture can be achieved with the use of short-stature or lodging-resistant cultivars irrigated during pod elongation (R3 to R4) and seed enlargement R5 to R6).

IRRIGATION OF SOYBEAN GENOTYPES DURING REPRODUCTIVE ONTOGENY II. YIELD COMPONENT RESPONSES,

Nebraska Univ.-Lincoln. Dept. of Agronomy L. L. Korte, J. E. Specht, J. H. Williams, and

Crop Science, Vol. 23, No. 3, p 528-533, May-June, 1983. 4 Fig, 1 Tab, 13 Ref. Nebr. Agric. Esp. Stn. projects 12-091 and 12-012.

Descriptors: \*Irrigation, \*Soybean yield, Phenology, Irrigation effects, Water stress, Soil moisture, Growth stage.

The magnitude of a seed yield increase that occurs when soybeans 'Glycine max. (L.) Merr.' are irrigated depends upon the phenologic timing of the irrigation in relation to the temporal sequence with which the components of seed yield are established and fixed. Eight soybean cultivars, varying in stem growth habit and maturity, were irrigated according to a factorial treatment design in which either no irrigation or one irrigation was applied at three reproductive stages: R1 to R2 flowering (F), R3 to R4 pod elongation (P), or R5 to R6 seed enlargement (S). An F irrigation increased the numbers of pods/plant (+2.8) and seeds/plant (+3.8), but an offsetting decrease occurred in 100-seed weight (0.9 g), resulting in little change in seed yield. A P irrigation had no effect on 100-seed weight, but increased the numbers of pods/plant (+3.4) and seeds/plant (+3.7) resulting in a large increase in seed yield. An S irrigation resulted in only slight increases in the numbers of pods/plant (+1.0) and seeds/plant (+3.3), but greatly increased 100-seed weight (+1.4 g), again leading to a large seed yield increase. These observations suggested that irrigation early in reproudctive ontogeny greatly reduced flower and pod abortion, whereas irrigation later in ontogeny reduced ovule abortion within developing pods. The cultivar 'Harcor' possessed The magnitude of a seed yield increase that occurs duced nower and pod abortion, whereas irrigation later in ontogeny reduced ovule abortion within developing pods. The cultivar 'Harcor' possessed unusually high numbers of one-and two-seed pods, while 'Elf' had substantially fewer numbers of three-seed pods, and 'Woodworth' possessed larger numbers of four-seed pods. Irrigation timing differnumbers of four-seed pods. Irrigation timing differentially influenced the frequencies of the various pod classes relative to their contribution to the increase in total pods/plant, primarily because of effects on ovule abortion within developing pods. The effects of irrigation timing on number of seeds/plant and 100-seed weight were thus consistent with the effects on seed yield reported earlier. (Author's abstract) (Author's abstract) W84-03280

ALFALFA RESPONSE TO SOIL WATER DEFI-CITS. I. GROWTH, FORAGE QUALITY, YIELD, WATER USE, AND WATER-USE EFFI-CIENCY, Minnesota Univ., St. Paul. Dept. of Agronomy and

Plant Genetics.
P. R. Carter, and C. C. Sheaffer.

Crop Science, Vol. 23, No. 4, p 669-675, July-August, 1983. 9 Fig, 3 Tab, 33 Ref. OWRT, USDI grant 14-34-0001-1236-B158 MINN.

Descriptors: \*Alfalfa, \*Soil water, \*Plant growth, \*Crop yield, \*Water use, \*Water use efficiency, Soil-water-plant relationships, Drought resistance, Irrigation effects, Evapotranspiration, Soil moisture deficiency, Leaves.

Although many researchers have reported yield increases due to alfalfa irrigation when soil water has been limited, little information is available on alfalfa plant and soil water relationships which might be used to improve water management strategies. Our objective was to determine effects of plant water deficits on alfalfa seasonal growth patterns, forage quality, forage yield, water use, and water-use efficiency. During 1981, established alfalfa grown on a sandy soil was subjected to four water supply levels designated: high irrigation (HJ), medium high irrigation (MH), medium lowi irrigation (ML), and unirrigated, rainfall only (U). Soil water depletions occurred for all treatments to at least 1.9 m. Alfalfa midday plant water potentials least 1.9 m. Alfalfa midday plant water potentials least 1.9 m. Alfalfa midday plant water potentials (psi mp) in H and MH treatments ranged from -0.7 to -1.3 MPa throughout the season. For alfalfa subjected to ML and U treatments, psi mp reached -2.7 and -4.0 MPa, respectively. Dry weight (DW) accumulations for alfalfa in H and MH treatments

increased with successive harvests during the summer while harvest DW for alfalfa in ML and U treatments declined. Relative growth rate (RGR) summer while harvest DW to attains in ML and U treatments declined. Relative growth rate (RGR) declined sharply as psi mp decreased. At moderate plant water stress (psi mp of -1.5 to -2.0 MPa), little growth occurred and under severe water stress, (psi mp of -1.5 to -2.0 MPa), little growth occurred and under severe water stress, (psi mp < -2.5 MPa), RGR were negative due to leaf loss. Reduced soil water availability resulted in increased leaf stem weight ratios and in vitro dry matter disapperance (IVDMD), but only under severe and long-term plant water stress. Crude protein (CP) concentration was unaffected by plant water status. It appeared that irrigation water could be used efficiently on coarse-textured soils by moderate water application to alfalfa at 50% depletion of extractable soil water, an apparent threshold for maintenance of favorable plant water status. A close associations between forage yield of individual harvests and cumulative psi mp indicates potential for initiation of irrigations when plant measurements indicate soil water depletions to a threshold level. (Author's abstract) WMA-07381 vel. (Author's abstract) 784-03281

ALFALFA RESPONSE TO SOIL WATER DEFI-CITS. II. PLANT WATER POTENTIAL, LEAF CONDUCTANCE, AND CANOPY TEMPERA-TURE RELATIONSHIPS, Minnesota Univ., St. Paul. Dept. of Agronomy and

For primary bibliographic entry see Field 2D. W84-03282

ALFALFA RESPONSE TO SOIL WATER DEFI-CITS. III. NODULATION AND N2 FIXATION, Minnesota Univ., St. Paul. Dept. of Agronomy and

Plant Genetics.
P. R. Carter, and C. C. Sheaffer.
Crop Science, Vol. 23, No. 5, p 985-990, September-October, 1983. 7 Fig, 2 Tab, 19 Ref.

Descriptors: \*Alfalfa, \*Soil moisture deficit, \*Ni-trogen fixation, Soil-water-plant relationships, Irri-gation effects, Plant water potential, Soil water

Harvesting of forage legumes removes the photo-synthate source necessary of remaintaining N2 fix-ation and nodule development. Water stress also depresses legume N2 fixation. In a field study on Typic Hapludoll (sitt loam) soil, nitrogenase specif-ic activity (NSA), nodule numbers, and shoot and root growth of irrigated and nonirrigated alfalfa were measured during a harvest/regrowth cycle. In a glasshouse study with Udorthentic Haplobor-oll (loamy sand) soil, NSA, nodulation, shoot and root growth, and root total nonstructural carbohyroot growth, and root total nonstructural carbohy-drate (TNC) concentration of nonharvested and harvested alfalfa were monitored during two suc-cessive harvest/regrowth cycles. Both harvest treatments were subjected to a range of soil and plant water deficits. Forage harvest decreased NSA and root TNC concentration for well-wa-NSA and root TNC concentration for well-watered alfalfa, but changes in NSA for water-stressed plants were more associated with fluctuations in plant water (psi p) and soil matric (psi m) potentials than to removal of herbage or level of root carbohydrates. Nitrogenase specific activity declined linearly as psi p decreased to -3.0 PMa, at which point activity approached zero. Alfalfa nodules subjected to severe water stress were able to resume activity when soil moisture levels were restored. Nodulation was inhibited by well-watered conditions (mean psi m of -0.07 to -0.51 MPa) in the loamy sand. (Murphy-IVI) IVI) W84-03283

ROLE OF PANICLE EXSERTION IN WATER

STRESS INDUCED STERILITY, International Rice Research Inst., Los Banos, Laguna (Philippines). Dept. of Agronomy. J. C. O'Toole, and O. S. Namuco. Crop Science, Vol. 23, No. 6, p 1093-1097, November-December, 1983. 3 Fig, 1 Tab, 22 Ref.

Descriptors: \*Panicle, \*Exsertion, \*Water stress, \*Sterility, Rice, Plant water Potential, Sprinkler

irrigation, Leaves, Rproductivity, Evapotranspira-

Although the sensitivity of crop species to water Attnough the sensitivity of crop species to waster stress during reproductive growth stages is well documented, the causes of sterility are not understood. Rice cultivar IR36 was grown on a deep sity loam soil under full sprinkler irrigation for 77 days. A line source sprinkler system was then utilized during panicle exsertion and flowering to more than the continuously decreasing irrigation freely. utilized during panicle exsertion and flowering to impose six continuously decreasing irrigation treatments. After the 15-day treatment period, full sprinkler irrigation was resumed until maturity. Soil moisture extraction and plant water potential were monitored as soil and plant water stress progressed. Panicle exsertion rate was measured on tagged panicles which were later used to assess percent final panicle exsertion and percent sterility. The six irrigation treatments varied in grain yield from 5.0 t/h to about 1 t/ha with corresponding increases in spikelet sterility of 16.6 and 74.2%. Panicle exsertion rate decreased linearly with decreasing mean daily leaf water potential. The degree of final panicle exsertion from the flagleaf sheath and percent spikelet sterility both decreased linearly with panicle exsertion rate. All spikelets left unexserted from the flagleaf sheath were sterile. Panicle exsertion rate was slightly confounded ile. Panicle exsertion rate was slightly confounded by tiller age in that late tillers in the well irrigated treatment had a slower exsertion rate and higher percent sterility than earlier tillers. The early tillers which exserted at rates of 4.5 to 5.5 cm/day under well watered conditions decreased to about 3.0 om/day in the stressed plot and accounted fo 25 to 30% spikelet sterility in the severely stressed treatment. (Murphy-IVI) W84-03284

SIGNIFICANCE OF ACCELERATED LEAF SE-NESCENCE AT LOW WATER POTENTIALS FOR WATER LOSS AND GRAIN YIELD IN MAIZE

Navarra Univ., Pamplona (Spain). Dept. Fisiologia Vegetal.

P. M. Aparicio-Tejo, and J. S. Boyer. Crop Science, Vol. 23, No. 6, p 1198-1202, November-December, 1983. 7 Fig, 19 Ref. NSF grant PCM 79-09790.

Descriptors: \*Leaves, \*Water potentials, \*Senescence, \*Water loss, \*Maize yield, Transpiration, cence, \*Water loss, \*Maize yield, 1 ranspiration, Stomatal transpiration, Dry matter, Water conser-

Productivity is lost when plants are subjected to dry soil conditions and this loss is often accompa-nied by the senescence of leaf tissue. The role of leaf senescence in water conservation and grain production was therefore evaluated in maize (Zea production was therefore evaluated in maize (Zea mays L.) subjected to low water potentials for most of the grain filling period. The plants were grown in soil in controlled environment chambers and water was withheld from the soil after pollination had occurred. Low leaf water potentials were maintained for 30 days (until the grain matured) by daily addition of small amounts of water to the soil. The low water potentials (-1.8 to -2.0 MPa) inhibited the matter ecompulation and transition. inhibited dry matter accumulation and transpira-tion by the plants. However, in addition to the initial inhibition of transpiration by stomatal clo-sure, there was a further inhibition (about 11% of sure, there was a further inhibition (about 11% of the control rate) associated with accelerated sense-cence of the leaves. Excision of senseced leaf tissue showed that, despite this inhibition of water loss attributable to senescence, the dead tissue itself continued to lose a small amount of water while attached to the plants. Although the low water potentials were of long enough duration to allow significant acclimation of the plants, the senescing tissue contributed only a small amount of dry matter to the erain by mobilizing leaf constituents. tissue contributed only a small amount of dry matter to the grain by mobilizing leaf constituents. Since the amount of water conserved by the sensening tissue was also small, it is likely that accelerated leaf senescence contributes little to grain production at low water potentials and has the disadvantage that it sacrifices potential photosynthetic surface. Therefore, selection against accelerated senescence of leaves at low water potentials may be desirable for crops. (Author's abstract) W84-03285

#### Group 21-Water In Plants

CROP-CLIMATE MODELING USING SPA-TIAL PATTERNS OF YIELD AND CLIMATE. PART 1: BACKGROUND AND AN EXAMPLE FROM AUSTRALIA,

PHOM AUSTRALIA, University of East Anglia, Norwich (England). Climatic Research Unit. T. M. L. Wigley, and T. Qipu. Journal of Climate and Applied Meteorology, Vol. 22, No. 11, p 1831-1841, November, 1983. 5 Fig, 3 Tab, 22 Ref.

Descriptors: \*Crop yield, \*Climates, \*Australia, Wheat, Model studies, Spatial distribution, Statistical models, Multivariate regression analysis.

Crop yield is certainly dependent on the weather conditions prevailing during, and sometimes prior to the growing season, expressing this dependence in terms of a reliable quantitative relationship, a crop-climate model, is a difficult task. The direct iking of spatial patterns of crop yield and spatial linking of spatial patterns of crop yield and spatial patterns of climate is a new statistical crop-climate analysis technique. Yield and climate data from networks of crop reporting districts and meteorological stations are decomposed into orthogonal components using principal components analysis. A function of the climate components is then used to express each yield component using multiple regression. The combining of these regression equations gives an equation which relates interannual variations in the spatial patterns of yield to interannual variations in the spatial patterns of selected climate variables. Wheat yield data from 59 crop reporting districts in southwestern Austra-59 crop reporting districts in southwestern Austra-lia from the period 1929-1975 are used to illustrate the method. The climate contribution is shown to be highly significant, with winter precipitation being the most important variable. A single equa-tion relating yield and climate patterns correctly reproduces the differing results obtained for sepa-rate parts of the study area by earlier workers. The influence of winter and autumn precipitation is nonlinear and the study divides therefore into three course, being the part where reinfell is connect. nonmear and the study divides therefore into three zones: a high rainfall area where rainfall is generally more than optimum so that lower rainfall gives higher yields; a low rainfall area where rainfall is less than optimum so that positive rainfall anoma-lies are associated with higher yields; and an inter-mediate zone where average rainfall is close to optimum so that anomalies in either direction sup-press yields. No evidence was found for any significant change in the sensitivity of wheat yields to climate in spite of a complete change in the variety of wheat cultivated. (Baker-IVI)

WATER USE BY ALFALFA, MAIZE, AND BARLEY AS INFLUENCED BY AVAILABLE SOIL WATER,

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SOIL WATER,
New Mexico State Univ., Las Cruces. Dept. of
Crop and Soil Sciences.
A. S. Abdul-Jabbar, T. W. Sammis, D. G. Lugg,
C. E. Kallsen, and D. Smeal.
Agricultural Water Management, Vol. 6, No. 4, p
351-363, 1983. 5 Fig. 2 Tab, 29 Ref. OWRT
projects A-063 N.Mex., B-069 N.Mex., and C90229.

Descriptors: \*Alfalfa, \*Corn, \*Barley, \*Water use, \*Soil water, Evapotranspiration, Available water, Sprinkler irrigation, Soil types.

The availability of soil water is one of the most important determinants of crop production. Field studies were conducted to examine the relationships between relative evapotranspiration (E/E sub max) and available water (W) for alfalfa, maize, and barley. Line source sprinkler irrigation systems were used to provide the variations in soil moisture. Actual evapotranspiration (E) was determined using the water balance method. Maximum evapotranspiration (E sub max) was the highest E observed among all irrigation levels. Potential eva-potranspiration (E sub 0) was estimated using Penman's equation to characterize the evaporative demand. The results show that the relationships between E/E sub max and W were different for between E/E sub max and w were different for the three crops. For alfalfa, the relationship was dependent on the physical properties of the soil and on E sub 0. In a clay loam soil, the declines in E from E sub max commenced at a higher value of W than in a sandy loam soil. Furthermore, the rate of decline in E from E sub max was dependent on E sub 0 and was greater as E sub 0 increased. In the sandy loam soil, the relationship between E/E sub max and W was not dependent on E sub 0. For maize and barley in clay loam soils, E/E sub max a function of W was linear, and was not dependent. as a runction of W was linear, and was not dependent on E sub o. This study was compared to results reported in the literature, and it was hypothesized that differences were related mainly to the way variation in soil moisture was introduced over the measurement period. (Author's abstract) W84-03444

WHEAT ROOT GROWTH, GRAIN YIELD AND WATER UPTAKE AS INFLUENCED BY SOIL WATER REGIME AND DEPTH OF NITROGEN PLACEMENT IN A LOAMY SAND SOIL

B. R. Sharma, and T. N. Chaudhary.

Water Management, Vol. 6, No. 4, p Agricultural Water Management, 365-373, 1983. 3 Fig, 3 Tab, 16 Ref.

Descriptors: \*Crop yield, \*Wheat, \*Soil water, \*Growth, \*Nitrogen, Irrigation effects, Water table, Water uptake, Roots, Water use.

Root growth, grain yield and water uptake by wheat in relation to soil water regime and depth of nitrogen (N) placement were studied in metallic cylinders filled with loamy sand soil. Root-length and weight densities were greater under irrigated than under un-irrigated conditions and they increased with deep placement as compared to surface mixing of fertilizer N. The differences were relatively larger in the deeper than in the upper soil layers and increased during later stages of plant growth. Under non-irrigated conditions, constant water table at 100 cm depth produced maximum root growth in the top 30 cm soil. Water uptake rate increased with increase in root density depending on root age and soil water status. Dry uptake rate increased with increase in root density depending on root age and soil water status. Dry matter accumulation at different stages of plant growth and grain yield varied significantly with moisture regime and depth of N placement. Deep placement of fertilizer N under shallow water table and non-irrigated conditions caused greater root growth, better water utilization and a higher production. (Author's abstract)
W84-03445

#### 2J. Erosion and Sedimentation

THE BEHAVIOUR OF SILT-LADEN CUR-

RENT, Ecole Polytechnique Federale de Lausanne (Switzerland). Lab. d'Hydraulique. W. H. Graf.

International Water Power and Dam Construction, Vol. 35, No. 9, p 33-37, September, 1983. 9 Fig, 11

Descriptors: \*Sedimentation, \*Reservoirs, Density currents, Gravity currents, Turbidity currents, Stratification, Stagnant water, Turbidity, Sediment transport, Silt.

Density currents are considered as they are encountered when sediment-laden river flow enters an almost stagnant water body, such as a reservoir or lake. Density currents have features in common with open-channel flows, but differ essentially because the buoyancy of the surrounding fluid reduces the gravity force by a normalized density difference. Gravity will inhibit the deep layer from mixing with the density current along the slope. Density currents may deposit sediments from the current onto the bed, errode sediments from the bed and carry them with the current, or may be steady that currents where a considering between the current of the curr state currents where an equilibrium between bed erosion and deposition exists. Proper knowledge of density current implications will aid in the determidensity current implications will aid in the determination of the loss of storage capacity as a result of settling out of suspended matter; the proper installation and operation of the opening gates which might well conserve a part of the storage capacity normally destroyed by deposition; the prediction and management of the lake's water quality (turnishing) and the property of the storage capacity the storage capacity of the lake's water quality (turnishing) and the storage capacity the storage capacity (turnishing) and the storage capacity of the lake's water quality (turnishing) and the storage capacity (the storage capacity capacity and the storage capacity and the storage capacity as a result of the lake's water quality (turnishing). bidity); the proper handling and use of density currents to empty out already accumulated sediment; and the avoidance of wear on hydraulic machinery and duct linings. (Baker-IVI) W84-02994

MODEL OF ADAPTATION OF ACTIVE-SILT ECOSYSTEM TO MULTICOMPONENT POL-

Akademiya Nauk SSSR, Moscow. Inst. Vodnykh

Problem.
V. A. Vavilin, and V. B. Vasil'ev.
Doklady Biological Sciences, Vol. 267, No. 1-6, p
554-558, November-December, 1982. 4 Fig. 4 Ref.
Translated from Doklady Akademii Nauk SSSR,
Vol. 267, No. 4, p 1012-1016, December, 1982.

Descriptors: \*Model studies, \*Ecosystems, \*Silt, Mathematical studies, Biomass, Oxidation, Sub-

A generalized model of the process of aerobic biological purification is based on the assertion that biological purification is based on the assertion that the composition of microorganisms in reactors performing the purification process depends upon the range of the processed pollutants. The latter is determined not only by the type of waste waters but also depends on the conditions of reactor operation. A system is examined with active silt, representing an ideal reactor-elutor in which pollutant oxidation and biomass accumulation occur, and a settling tank in which the biomass is compacted and then returned to the reactor-aeration tank. The model demonstrated that to each magnitude of silt stress there corresponds a specific species compositions. stress there corresponds a specific species composi-tion of the active-silt microflora. The fraction of species oxidizing those difficult to oxidize pollutant species oxidizing those difficult to oxidize pollutant components increases with a decline in silt stress. The purification effect increases when a multistage purification is used, where the microorganism spe-cies composition is formed at each stage. (Baker-W84-03026

DECOMPOSITION OF ORGANIC MATTER IN LAKE SEDIMENTS,

Agricultural Research Service, Durant, OK. Water Quality and Watershed Research Lab. Y. Avnimelech, J. R. McHenry, and J. D. Ross. Environmental Science and Technology, Vol. 18, No. 1, p 5-11, January, 1984. 4 Fig, 4 Tab, 28 Ref.

Descriptors: \*Lake sediments, \*Decomposing organic matter, \*Lake sediments, Deposition, Estuaries, Reservoirs, Mathematical models, Carbon, Nitrogen, Phosphorus, Depth, Diagenesis.

With the use of mathematical calculations the decreases with depth of organic carbon, nitrogen, and total phosphorus in sediments from 64 lakes, reservoirs, and estuaries across the United State reservoirs, and estuaries across the United State were in agreement with a first-order kinetic model. The average rate coefficients for C, N, and P were 24/1000, 21/1000, and 5/1000 per year, respectively. The corresponding modes of the rate coefficients were 4/1000, 5/1000, and 4/1000 per year, respectively, for C, N, and P. The constants for C and N are closely related and reflect the microbial decomposition of these components. The P decay coefficient is probably related to the decomposition of organic P and subsequent upward P diffusion. The decay coefficients would be used as a general first approximation to the rates of organic matter diagenesis in sediments. (Murphy-IVI) W84-03032

EROSION IN THE PALOUSE: AN AERIAL PERSPECTIVE,
Agricultural Research Service, Pullman, WA.

B. E. Frazier, D. K. McCool, and C. F. Engle. Journal of Soil and Water Conservation, Vol. 38, No. 2, p 70-74, March-April, 1983. 10 Fig, 11 Ref.

Descriptors: \*Aerial photography, \*Erosion, Erosion control, Monitoring, Data acquisition, Pa-

Aerial photography is an effective tool for study-ing soil erosion and determining the success or failure of management practices to control it. In many cases spatial relationships between cultiva-

#### Erosion and Sedimentation—Group 2J

tion and eros. In patterns can only be viewed from above ground as only a portion of any slope is visible from the ground. The significance that can be extracted from photographs of rill patterns de-pends on the factors involved in the formation of pends on the factors involved in the formation of rills. Basic rill patterns develop on slopes that are seeded across the slope into soil pulverized by summer fallow and where all runoff originates within the rilled area. These rill patterns are simple dendritic on concave slopes, parallel on straight slopes, and divergent on convex slopes. Other areas offer no photographable patterns such as eroded ridge crests, isolated and eroded knobs, and broad, concave alluvial lands. (Baker-IVI) W84-03052

## SOIL EROSION ON SUBARCTIC FOREST

SOIL ERGSION ON SUBMERTAL STATES STOPES, Hydrocon, Inc., Fairbanks, AK. J. W. Aldrich, and C. W. Slaughter. Journal of Soil and Water Conservation, p 115-118, March-April, 1983. 6 Fig, 5 Tab, 18 Ref.

Descriptors: "Soil erosion, "Subarctic zone, "Forest soils, "Slopes, Soil stability, Rill erosion, Sheet erosion, Logging, Clear cutting, Runoff, Vegetation, Mathematical models.

The universal soil loss equations is applied to a study site on the Caribou-Poker Creeks Research Watershed (Alaska) in order to assess the suitability of the equation for predicting sheet-rill erosion in Alaska's interior. When a permafrost-free subarctic setting is stripped of all vegetation from the soil surface, an increase in rainfall erosion is 16 times that produced from an undisturbed forest. The rate difference is from 0.008 ton per acre per year to 0.13 ton per acre per year. Removing the trees from a forested area, with only minor disturbance of ground cover, did not increase erosion. A vehicle trail on permafrost terrain had a very low erosion rate of 0.03 ton per acre per year. Comparison of measured erosion with erosion predicted by the universal soil loss equation indicated that the ison of measured erosion with erosion predicted by the universal soil loss equation indicated that the equation overestimated annual rainfall erosion by an average of 21% and overestimated individual storm erosion by an average of 174%. The stand-ard deviation of the mathematical model was 328%. (Murphy-IVI) W84-03056

## SOIL AND NUTRIENT RUNOFF LOSSES WITH IN-ROW, CHISEL-PLANTED SOY-BEANS,

DEANS, Agricultural Research Service, Watkinsville, GA. G. W. Langdale, H. F. Perkins, A. P. Barnett, J. C. Reardon, and R. L. Wilson, Jr. Journal of Soil and Water Conservation, p 297-301, May-June, 1983. 1 Fig, 5 Tab, 20 Ref. servation, p 297-301,

Descriptors: \*Soil erosion, \*Nutrients, \*Runoff, \*Soybeans, \*Conservation tillage, Agricultural runoff, Crop residues, Nutrient losses, Mulches,

Coulter, in-row chiseling 20 centimeters deep in rey stubble effectively controlled runoff (less than or equal to 13%) on rainulator plots (10.7- and 21.4-meter slope lengths) with a 7% slope until water content in the topsoil approached 14.2% (about 0.1-bar suction). In-row chiseling and soil cover collectively reduced soil losses during rainulator runs to less than 0.5 metric ton per hectare on both slope lengths. Increased slope length led to increased runoff, event with low soil water content during soybean canopy development. Removing crop residue and destroying the chisel slot with complete tillage caused soil losses exceeding 40 compilete tilinge caused son losses exceeding 40 metric tons per hectare. Runoff-weighted nutrient losses related positively to soil losses. Increased slope length consistently increased nutrient losses during all tillage-soil cover sequences. Most nutrient loss variation was accounted for by treating soil loss as an independent variable during the rye mulch cover period. Phosphorus losses were correlated better to soil losses among tillage-soil cover sequences than to the cations. Coulter, in-row, sequences than to the cattons. Coulter, In-row, chisel-planted soybeans through rye residues fol-lowing winter-spring cattle grazing of rye effec-tively controlled runoff as well as soil loss and some nutrient losses. (Murphy-IVI)

#### SOIL EROSION FROM FIVE SOVBEAN TILL. AGE SYSTEMS.

Tennessee Univ., Knoxville. Dept. of Agricultural eering.

Engineering. C. H. Shelton, F. D. Tompkins, and D. D. Tyler. Journal of Soil and Water Conservation, p 425-428, September-October, 1983. 8 Tab, 6 Ref.

Descriptors: \*Soil erosion, \*Soybeans, \*Tillage, Runoff, Rainfall, Simulation, Soil types, Loess, Agricultural runoff.

Runoff from natural and simulated rainfall on 0.25 acre plots caused significant soil losses from soy-bean plots and five different tillage systems on a bean plots and five different tillage systems on a highly erodable soil in West Tennessee. Soil losses generally were greatest for the conventional-till, single-crop soybean system, followed in order by drilled soybeans; conventional-till, double-cropped soybeans; no-till, double-cropped soybeans; and no-till, single-cropped soybeans. Weed control was attained without the use of herbicides. Because each of the five systems has advantages and disadvantages, a program of rotating alternate strips of a no-till system with a conventional-till, double cropped system would have merit. To control erosion and accompanying loss of nutrients, howerosion and accompanying loss of nutrients, how-ever, each system should provide soil cover when high-energy rainfall is most likely to occur. high-energy (Murphy-IVI) W84-03066

## OBSERVATION OF EPISODIC SEDIMENTA-TION IN A TIDAL INLET (SABINE PASS, TEXAS AND LOUISIANA),

Espey, Huston and Associates, Inc., Austin, TX. For primary bibliographic entry see Field 2L. W84-03107

## PROBABILITY SAMPLING TECHNIQUES FOR ESTIMATING SOIL EROSION,

Utrecht Rijkuniversitet (Netherlands). Dept. of Physical Geography.
J. M. Roels, and P. J. Jonker. Soil Science Society of America Journal, Vol. 47, No. 6, p 1224-1228, November/December, 1983. 5 Fig, 4 Tab, 11 Ref.

Descriptors: \*Soil erosion, \*Sampling, \*Probability, Rill erosion, Interrill erosion, Soil loss, Ardeche drainage basin, France,

Soil erosion in a particular area can be estimated from measurements at sites which are thought to be representative of the entire area. Modified Gerlach troughs were used to measure both rill and interrill erosion in the rangelands of the Ardeche drainage basin in France. Random, systematic, stratified random, and cluster sampling methods were tested for various numbers of plots and plot widths in order to find the method that gives the most accurate estimate of soil loss. If both the rill and interrill subpopulations are sampled, random and interrill supopulations are sampled, random sampling and stratified random sampling give almost identical standard errors. Cluster sampling yields large errors and is therefore less effective. Systematic sampling, however, allows one to choose more accurate samples of an economical size, but its efficacy depends largely on the number size, but its efficacy depends largely on the number of rills in the study area. The smallest standard errors are obtained by measuring the total rill erosion and by sampling only the interrill subpopulation. When this procedure is applied, the four sampling methods turn out to be equally accurate. The size and number of erosion plots to be used in soil loss measurements in a study area depend on the purpose of the experiments. Only for a rapid exception of the processor of the experiments. reconnaissance of the extent of soil erosion are data with low or unknown accuracy acceptable. Proba-bility sampling techniques allow the accuracy of the plot data to be determined. (Moore-IVI)

## RAINFALL EROSION INDICES FOR CANADA EAST OF THE ROCKY MOUNTAINS,

Department of Agriculture, Guelph (Ontario). G. J. Wall, W. T. Dickinson, and J. Greuel. Canadian Journal of Soil Science, Vol. 63, No. 2, p 271-280, May, 1983. 4 Fig. 3 Tab, 13 Ref.

Descriptors: \*Rainfall index, \*Erosion, Canada, Rocky Mountains, Mountains, Soil loss, Mathematical equations.

Relatively simple techniques for estimating average annual rainfall erosion indices and seasonal distribution patterns of rainfall erosion yield values comparable to those determined by more tedious methods in the United States. These techniques have proven to be extremely useful for the devel-opment of a first approximation of rainfall erosion indices for Canadian locations east of the Rocky Mountains. There is a significant range of rainfall erosion index values across the country. There are definite regional patterns for both the annual index ucumize regional patterns for both the annual index and the monthly distributions. The data base of climatic stations used in this study has proven to be large enough to yield realistic broad patterns for a large portion of Canada. (Baker-IVI) W84-03225

### ESTIMATES OF SOIL EROSION AND DEPO-SITION FOR SOME SASKATCHEWAN SOILS, Saskatchewan Univ., Saskatoon. Dept. of Soil Sci

E. De Jong, C. B. M. Begg, and R. G. Kachanoski. Canadian Journal of Soil Science, Vol. 63, No. 3, p 607-617, August, 1983. 2 Fig, 6 Tab, 22 Ref.

Descriptors: \*Erosion, \*Estimating, Saskatchewan, Soil loss, Water erosion, Wind erosion, Universal soil loss equation, Mathematical equations.

Traditional cultivation practices involving large tracts of land in summerfallow have encouraged wind and water erosion on the Prairies and have reduced soil fertility. Actual measurement of soil loss by erosion can be obtained from field plots maintained over many years. Cs-137 from the atmospheric testing of nuclear devices in the 1950s and 1960s was used to estimate soil erosion in eight small basins in humanchy topography. Three and 1906 was used to estimate soil crossion in eight small basins in hummocky topography. Three basins had not been cultivated since 1950 and in these Cs-137 showed little or no separation accord-ing to landscape position. In the cultivated basins Cs-137 varied significantly with slope position and could be used to identify areas of soil loss and deposition. The Cs-137 distribution in the cultivatdeposition. The Cs-137 distribution in the cultivative debasins indicates the simultaneous occurrence of erosion on the upper slope and deposition on the lower slope areas. Therefore the universal soil loss equation (USLE) is difficult to apply on this topography. The Cs-137 data could be used to estimate rates of soil loss or deposition at specific slope positions. The results of the Cs-137 balances did did the contract of the country o positions. In cost of the Cost of state of the cost of W84-03228

## SOIL EROSION AND PRODUCTIVITY, A RATIONAL LOOK AT A COMPLEX SITUATION, sota Univ., Minneapolis. Dept. of Soil Sci-

W. E. Larson, F. J. Pierce, and R. H. Dowdy. Crops and Soil Magazine, Vol. 35, No. 9, p 19-20, August-September, 1983. 2 Fig.

Descriptors: \*Soil erosion, \*Crop yield, Acidity, Universal Soil Loss Equation, Corn Belt, United States, Erosion, Topsoil, Subsoil.

Various factors influence the productivity of a Various factors influence the productivity of a crop. Among these are the nature of the soil, the weather, the plant variety, such external sources as lime and fertilizer, and the management of all of these resources. The way a soil erodes and where it goes can both affect soil productivity. If the soil in leaving takes seedling plants with it, there will be an obvious decrease in crop production that year. If it leaves large gullies behind that cannot be farmed in the future, then the future yield is also affected. Soil eroding from a hillside and being affected. Soil eroding from a hillside and being deposited on a low spot on a field can either be detrimental or beneficial to productivity, depending on the landscape. Loss in productivity is thought to be greatest on slopes exceeding 6% and when subsoil properties are unfavorable for crop growth. About 29% of the cropland in the United

#### Field 2-WATER CYCLE

#### Group 2J-Erosion and Sedimentation

States is on slopes steeper than 6%. On generally fertile and deep soils of the Corn Belt, potential productivity will probably decline less than 10% in the next 50 years. (Baker-IVI) W84-03231

RELATIONSHIP OF RUNOFF AND SOIL LOSS TO GROUND COVER OF NATIVE AND RECLAIMED GRAZING LAND,

Science and Education Administration, Mandan, ND. Northern Great Plains Research Center. For primary bibliographic entry see Field 2E. W34-03256

SEDIMENT SAMPLING IN DIFFERENT AQUATIC ENVIRONMENTS: STATISTICAL ASPECTS,

National Swedish Environment Protection Board. For primary bibliographic entry see Field 5A. W84-03411

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A DYNAMIC MODEL OF BASIN SEDIMENT YIELD,

Institute of Hydrology, Wallingford (England). R. J. Moore.

Water Resources Research, Vol. 20, No. 1, p 89-103, January, 1984. 34 Ref.

Descriptors: \*Sediment yield, \*Sediment transport, \*River basins, \*Mathematical models, Suspended sediments, Storm runoff, Floods.

A model of basin sediment yield was developed on the basis of continuous time functions which are twice-differentiated in the parameter space, thereby avoiding the function minimization problems encountered when calibrating models that employ threshold elements. The model predicts the hourthreshold elements. In model predicts the hour-to-hour variation in basin suspended sediment yield, incorporating the phenomenon that yields are influenced by the availability of sediment, as well as the capacity of flow to transport sediment. This is achieved through the definition of three model functions: an availability function; a removal function; and a translation function. The inverse Gaussian probability density function is introduced as a suitable translation function because of its as a suitable translation function because of its shape and its physical interpretation in terms of Saint Venant equations of open channel flow, the equations of groundwater flow, and the general convection-diffusion equation. A censored objective function is employed to facilitate efficient model calibration in circumstances where significant estimate triples are produced by infragregate. model calibration in circumstances where signifi-cant sediment yields are produced by infrequently occurring flood events, but the changing availabil-ity of sediment between storm events demands that the model be run continuously over time. Adop-tion of a modeling strategy based on the use of smooth but physically plausible functions was an important concern and motivation in developing the new model. The performance of basin sediment yield models must be severely limited on account of the complexity of the sediment yield process at the basin scale and the paucity of data usually available. This lack of definition at the basin scale provides a persuasive argument in favor of si models which represents the dominant mod inant modes of behavior of the system. (Moore-IVI) W84-03415

ANALYTICAL SOLUTIONS OF KINEMATIC EQUATIONS FOR EROSION ON A PLANE, IL RAINFALL OF FINITE DURATION,

Louisiana State Univ., Baton Rouge. Dept. of Civil Engineering. V. P. Singh

Advances in Water Resources, Vol. 6, No. 2, p 88-95, June, 1983. 15 Fig, 6 Ref. NSF project ENG. 79-23345.

Descriptors: \*Rainfall, \*Mathematical equations, \*Erosion, Erosion control, Kinematics, Water flow, Sedimentation.

Analytical solutions are derived to kinematic equations for erosion from a sloping plane subject to rainfall of finite duration. Both equilibrium and partial equilibrium cases are distinguished. Com

plete solutions of these cases have not appeared previously in hydrologic literature. Properties of these solutions are briefly discussed. A procedure is suggested for estimating the parameters con-tained in these solutions. (Baker-IVI) W84-03462

BED LOAD FORMULAE FOR ALLUVIAL

BED LOAD FORMACE.

CHANNELS,
University of Petroleum and Minerals, Dhahran (Saudi Arabia). Dept. of Civil Engineering.

N. A. Zaghloul.

Advances in Water Resources, Vol. 6, No. 2, p 112-120, June, 1983. 18 Fig, 14 Ref.

Descriptors: \*Alluvial channels, \*Bed load, Sediment load, Channels, Sedimentation, Slopes, Mathematical equations, Kalinske's equation.

Because of the complexity and random nature of Because of the complexity and random nature of the problem of deposition and scour, the approach-es to the study of these problems are empirical, or semi-empirical at best. Among the popular bed load formulae, Kalinske's equation gave the best correlation with the experimentally determined sediment discharge. The values of the energy slope, calculated by the resistance equations, are in stope, calculated by the resistance equations, are in reasonable conformity with the experimental values. A relatively better agreement was found for the starvation case than for sedimentation. The procedure which combines the bed load formulae and resistance equation produced reliable results for the conditions tested, and therefore, is recommended for practical application under the same conditions. (Baker-IVI)

W84-03464

FLOCCULENT SETTLING IN QUIESCENT

SYSTEMS, Geraghty and Miller, Inc., Baton Rouge, LA. For primary bibliographic entry see Field 5D. W84-03475

#### 2K. Chemical Processes

NITROGEN FIXATION AND PHOSPHORUS TURNOVER IN A HYPERTROPHIC PRAIRIE

LAKE, National Water Research Inst., Burlington (Ontario). Aquatic Ecology Div.
For primary bibliographic entry see Field 2H.
W84-03015

HYDROLOGIC CONTROL OF LAKE SUSCEP-TIBILITY TO ACIDIFICATION, Wisconsin Dept. of Natural Resources, Rhine

J. M. Eilers, G. E. Glass, K. E. Webster, and J. A.

Rogalla. Rogania. Canadian Journal of Fisheries and Aquatic Sciences, Vol. 40, No. 11, p 1896-1904, November, 1983. 3 Fig. 4 Tab, 46 Ref. EPA grant CR 809484.

Descriptors: \*Acidification, \*Hydrology, \*Wisconsin, \*Lakes, Surface runoff, Groundwater, Precipitation, Acidity, Chemistry of precipitation, Cluster analysis, Alkalinity, Inlets, Outlets.

Two hundred and seventy-five lakes were sampled in the summer of 1979 to assess the factors controlling susceptibility of northcentral Wisconsin lakes to acidification. In addition to direct evaluation of means and ranges of the physical and chemical characteristics, a cluster analysis was carried out using alkalinity, color, and chlorophyll a data. Three well-defined clusters emerged that appeared to be controlled by hydrology; A - dominated by surface runoff; B - dominated by groundwater; C - dominated by precipitation. Lake water quality and susceptibility are influenced by morphometric, hydrologic and terrigenous factors in 18 water-hydrologic and terrigenous factors in 18 waterand susceptionity are influenced by morphometric, hydrologic and terrigenous factors in 18 water-sheds analyzed. Hydrologic factors were most important in differentiating the low alkalinity and high alkalinity lakes. The potentially sensitive low alkalinity lakes in northcentral Wisconsin lack surface inlets or outlets and their chemistry is closely associated with precipitation chemistry. (Murphy-IVI 784-03017

FLUORIDE IN THE GROUND TER OF NORTHEASTERN OHIO,

Akron Univ., OH. Dept. of Geology. For primary bibliographic entry see Field 2F. W84-03073

THE GEOCHEMISTRY OF IRON AND MAN-GANESE IN THE WATERS AND SEDIMENTS OF BOLSTADFJORD, S. W. NORWAY,

Lancaster Univ., Bailrigg (England). Dept. of Ennental Scie J. H. Taylor, and N. B. Price.

Estuarine, Coastal and Shelf Science, Vol. 17, No. 1, p 1-19, July, 1983. 6 Fig, 3 Tab, 53 Ref.

Descriptors: \*Geochemistry, \*Iron, \*Manganese, \*Sediments, \*Bolstadfjord, \*Norway, Interstitial water, Coastal waters, Physiochemical properties, Eddies. Fate of pollutants.

The near-surface circulation of Bolstadfjord is runoff dominated, while the deep waters are greatly restricted by the presence of shallow sills. The distribution of suspended particulate matter is closely allied to the general circulation, with the highest concentrations in the freshwater surface outflow. Elevated concentrations of dissolved and suspended particulate. Exp. and Ma. are associated. outflow. Elevated concentrations of dissolved and suspended particulate Fe and Mn are associated with restricted deep waters as a result of redox reactions and with river discharge. The basin sediments are anoxic throughout but because of the greatly restricted circulation, remobilized Fe and Mn appear to remain predominantly trapped within the fjord. Differentiation of Fe and Mn occurs to the extent that Fe sulfide precipitation is bulguitous in the sediments whereas the entranoccurs to the extent that Fe sulfide precipitation is ubiquitous in the sediments whereas the entrapment of Mn, probably through Mn carbonate precipitation, is found only in the sediments of the more seaward basin (maximum Mn content of 1.5% by weight). The main controlling factors are probably a gradual build-up of Mn in the system and an increasing vertical eddy diffusion coefficient with depth. (Murphy-IVI)

CARBON DIOXIDE EMISSION AND CARBON ACCUMULATION IN COASTAL WETLANDS, Louisiana State Univ., Baton Rouge. Center for Wetland Resources.

For primary bibliographic entry see Field 5B. W84-03136

INVESTIGATIONS ON HEAVY METAL SPECIATION IN NATURAL WATERS BY VOLTAMMETRIC PROCEDURES,

Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.). Inst. fuer Angewandte Physikalische For primary bibliographic entry see Field 5B. W84-03185

MATERIAL BALANCE OF AQUATIC ECOSYSTEMS AND CHEMICAL BINDING (VOM STOFFHAUSHALT AQUATISCHER OKOSYSTEME ZUR FRAGE NACH DER CHEMIS-CHEN BINDUNG),

Neuchatel Univ. (Switzerland). Inst. de Chemie. P. Baccini. Fresenius Zeitschrift fur Analytische Chemie, Vol. 316, No. 6, p 575-581, November, 1983. 14 Fig, 11

Descriptors: \*Ecosystems, \*Copper, \*Phosphorus, \*Chemical binding, Iron hydroxide, Hypolimnion, Boundary conditions, Sediments, Organic matter, Nutrients, Bioavailability.

A system-analytical investigation of ecosystems elucidates those physical-chemical and biochemical processes which are relevant for the whole system. The system's balance of element and compound fluxes reflects the capacity of the 'biological program' to retain different chemical species for a gram' to retain different chemical species for a longer or shorter time. This capacity is illustrated with copper(II) aqua ions and orthophosphate ions in an aquatic system. For phosphorus, a limiting nutrient in a lake, the biological subsystem 'sediment boundary layer' plays a crucial role. Within

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this boundary layer an iron(III) hydroxide barrier reduces the phosphorus reflux into the hypolim-nion. In the case of copper, an essential element having a toxic concentration in a purely inorganic having a toxic concentration in a purely inorganic form, natural dissolved organic matter reduces its bioavailability due to the formation of organic copper complexes. These dissolved forms of copper are exported more quickly. For both nutrients there is still a lack of data on the kinetics and the chemical nature of the chemical binding in the first (Cu) and the second sphere of coordination (P) with respect to the boundary conditions found in aquatic eccoystems. (Author's abstract) W84-03186

CARBONATE MINERALOGY OF LAKE SEDI-MENTS AND SURROUNDING SOILS I. BLACKSTRAP LAKE,

Saskatchewan Univ., Saskatoon. Dept. of Soil Sci-

ence. K. Ghebre-Egziabhier, and R. J. St. Arnaud. Canadian Journal of Soil Science, Vol. 63, No. 2, p 245-257, May, 1983. 5 Fig, 4 Tab, 28 Ref. NSERC Grant No. A1446.

Descriptors: \*Lake sediments, \*Mineralogy, Lakes, Blackstrap Lake, Saskatchewan, Canada, Carbonates, Minerals, Magnesium, Calcite, Dolomite. Erosion, Calcium, Chemical composition

Carbonate minerals constitute an important fraction of many lake sediments. No detailed studies have yet been undertaken to establish the relationship between the carbonate mineralogy of lake sediments and that of surrounding soils and deposits. The similarity in carbonate mineralogy of the sediments and that of surrounding soils and deposits. The similarity in carbonate mineralogy of the silt and clay fractions of the Blackstrap sediments to those of the surrounding soils suggests that erosional processes have contributed to the present composition of the lake sediment. In particular, the persistence of dolomite in the silt fractions of the lake sediment is a good indication that part of the calcite together with the dolomite are derived from the surrounding soils. However, the higher carbonate contents of the sediment fractions also indicate that the precipitation of carbonates from the lake waters has been and is likely to still occur. the lake waters has been and is likely to still occur. Mollusk shells also contribute to this increase. The Moliusk snells also contribute to this increase. I he presence of Mg-bearing calcite in the lake sediment is attributed to the pecipitation of calcite over a period during which the Mg(2+) ion concentration in the lake was increasing in relation to the Ca(2+) ion concentration. It appears that the Mg:Ca ratio of the waters has a similar effect on the nature of precipitated carbonates as that evident in more described and carbonates as the carbonates as dent in marine deposits and soils. The unusual presence of Mg-bearing calcite in the sand fraction is attributed to the cementation of finer particles into sand-sized aggregates. (Baker-IVI) W84-03223

LAGRANGIAN METEOROLOGY AND MEAS-UREMENTS OF ACIDIC PRECIPITATION AT WASHINGTON, D.C., National Oceanic and Atmospheric Administra-tion, Rockville, MD. Air Resources Labs. For primary bibliographic entry see Field 5B. W84-03286

A COMPARATIVE STUDY OF THE IONIC COMPOSITION OF RAINWATER AND ATMOSPHERIC AEROSOLS: IMPLICATIONS FOR THE MECHANISM OF ACIDIFICATION

OF RAINWATER, Lancaster Univ., Bailrigg (England). Dept. of Environmental Sciences

Atmospheric Environment, Vol. 17, No. 12, p 2539-2543, 1983. 1 Fig, 2 Tab, 27 Ref.

Descriptors: \*Rainfall, \*Chemical composition, Chlorides, Nitrates, Sulfates, Magnesium, Potassi-um, North-West England, England.

Measurements of the chemical composition of rain-water and suspended particles collected in parallel at a rural site in North-West England have shown that sulfate, nitrate, chloride, ammonium, sodium, magnesium, potassium, and calcium ions constitute the main ionic species in atmospheric aerosols and

rainwater. Sodium and magnesium are associated with chlorides and originate from sea salt spray. Comparative concentrations in rainwater and parallel aerosol samples indicate that rainout and washout mechanisms are effective in the deposition of sea salt aerosols at this sampling site. Acidity was only present to any appreciable degree in rainwater samples. It appears that at least in this region where the levels of NH3 in the lower atmosohere are usually high and annual rainfall is region where the levels of NH3 in the lower atmosphere are usually high and annual rainfall is appreciable, the deposition of acidity is mainly due to wet deposition. Washout and principally rainout mechanisms are efficient in the removal of anthro-pogenic sulfur compounds. (Baker-IVI) W84-03287

CHEMICAL COMPOSITION OF WATER-BODIES IN THE ENGLISH LAKE DISTRICT: RELATIONSHIPS BETWEEN CHLORIDE AND OTHER MAJOR IONS RELATED TO SOLID GEOLOGY, AND A TENTATIVE BUDGET FOR WINDERMERE, Freshwater Biological Association, Windermere (England)

(England).
D. W. Sutcliffe, and T. R. Carrick.
Freshwater Biology, Vol. 13, No. 4, p 323-352,
August, 1983. 13 Fig, 14 Tab, 87 Ref.

Descriptors: \*Chemical composition, \*Lakes, \*Chlorides, \*Sodium, \*Ions, \*Geohydrology, \*Windermere, England, Pollution load, Water pollution sources, Groundwater budget, Groundwater pollution, Quantitative analysis.

It is well known that relative proportions and concentrations of most major ions in surface waters are basically dependent on the type of rocks and soils in the catchments. Sodium and chlorine ions are notable exceptions, particularly in maritime regions where it is believed these two ions are cyclically derived largely if not entirely from the coeans, via precipitation, and are concentrated in cyclically derived largely if not entirely from the coeans, via precipitation, and are concentrated in runoff by evaporation. Mean tarnwater concentrations of Cl(-) and other ions (Na(+), K(+), Ca2(+), Mg2(+), SO4(2-) + NO3(-))decrease with increasing distance from the sea and altitude but are related to solid geology. Lowest concentrations occur on slow-weathering igneous rocks (Borrowdale Volcanics); minima of c. 100 microcquiv. Cl(-)/I are similar to the volume-weighted mean for bulk precipitation. At least 10-20% of Na(+) is leached from upland catchments, giving Na(+)/Cl(-) ratios greater than the equivalent ratio (0.86) in seawater and precipitation. Evaportranspiration at 20-30% annual rainfall accounts for Cl(-) concentrations in many tarns on igneous transpiration at 20-30% annual rainfall accounts for Cl(-) concentrations in many tarns on igneous rocks but not all; some Cl(-) may be leached from the rocks in upland catchments and come from groundwaters at low altitudes near the sea. Seaspray has little influence on tarnwaters near the coast. On sedimentary rocks overall mean Cl(-) concentrations are 27-73% higher than equivalent means on Borrowdale Volcanics; concentrations of other ions are also higher. A 5-fold to 10-fold range of Cl(-) concentrations is not simply due to increased evapotranspiration. Na(-+)/Cl(-) ratios are < 0.86, especially on Skiddaw Slates where tarn waters contain 10% or more excess Cl(-) balanced by Ca(2+-), apparently derived from groundwaters rich in CaCL2. On other sedimentary rocks (Silviran Slates and Carboniferous, Triassic rocks (Silurian Slates and Carboniferous, Triassic and Permian series) tarn waters display a similar but less pronounced excess of Cl(-) and Ca(2-)(+) relative to Na(+). Some extra Cl(-) and Ca(2-)(+) relative to Na(+). Some extra Cl(-) may be captured by dry deposition on vegetation but a portion, perhaps 15-30% of the total, apparently comes from the rocks or from groundwaters via deep aquifers in contact with seawater or connate water. In anthropogenic sources on the catchments decicing salt used on highways in winter accounts for a 27% increase of CI(-) in Windermere South Basin over a 20-year period. (Murphy-IVI) W84-03293

RELATIONSHIPS BETWEEN CHLORIDE AND MAJOR CATIONS IN PRECIPITATION AND STREAMWATERS IN THE WINDER-MERE CATCHMENT (ENGLISH LAKE DIS-

Freshwater Biological Association, Windermere

For primary bibliographic entry see Field 5B. W84-03297

THE CONTRIBUTION OF HUMIC SUB-STANCES TO THE ACIDITY OF COLORED NATURAL WATERS,

Canada Centre for Inland Waters, Burlington (On-

B. G. Oliver, E. M. Thurman, and R. L. Malcolm. Geochimica et Cosmochimica Acta, Vol. 47, No. 11, p 2031-2035, November, 1983. 1 Fig, 2 Tab, 31 Ref.

Descriptors: \*Acidity, \*Water analysis, \*Humic acids, Wetlands, Groundwater, Nova Scotia, Rivers, Lakes, Streams, Fulvic acids.

Many natural waters contain low concentrations of dissolved solids, have low conductivity and possess dissolved solids, have low conductivity and possess little alkalinity, so they are highly susceptible to the effects of acid precipitation. An operationally defined carboxy content of humic substances extracted from rivers, streams, lakes, wetlands, and groundwaters throughout the United States and Canada is presented. Despite the diversity of the samples, only small variations were noted in this humic carboxyl content. The dissociation behavior of two combined fulvic-humic acid extracts was studied and the dissociation of the humics varied in a predictable manner with pH. Using a carboxyl content of 10 microecy/mg humic organic carbon, and mass action quotient calculated from sample pH, the ionic balances of three highly colored Nova Scotia rivers were examined. The acidity contribution of humic substances to a watershed Nova Scotta rivers were examined. The acidity contribution of humic substances to a watershed was concluded to be equivalent to the carboxylate anion concentration and so can be estimated for colored or dystrophic waters by these procedures. A portion of the acidity may be released in weathering and/or ion exchange reactions in the watershed's soils or sediments. Once the humic materials reach the watercourse, further budges inns may reach the watercourse, further hydrogen ions may be released through dissociation. This acidity may be present as free hydrogen ions in the water or may be consumed by neutralization reactions in the watercourse. (Baker-IVI)

ACID PRECIPITATION - AN INTERNATION-AL ENVIRONMENTAL PROBLEM, Norsk Inst. for Vannforskning, Oslo.

L. N. Overrein. Water Science and Technology, Vol. 15, No. 12, p 1-7, 1983. 5 Ref.

Descriptors: \*Acid rain, \*International environmental effects, Environmental effects, Sulfur compounds, Nitrogen compounds, Metals, Industrial development Air pollution, Europe, North Amer-

Acidification is a trans-World problem. The con-Acidination is a trans-world protein. The con-cept of acidification is bound up with the discharge into the atmosphere of sulfur dioxide, nitrogen oxides, and metals and other micropollutants, and the subsequent effects of these substances on the environment. The bulk of man-made emissions occurs over industrialized regions covering less than 5% of the earth's surface. In these regions, man-made emissions exceed the natural emissions by a factor of five to twenty. In the 1950's a sharp by a factor of five to twenty. In the 1950's a sharp rise in oil combustion increased the SO2 emissions in Europe to about 25 million tons of sulfur per years by 1970. European emissions of NO sub x have increased from low values 100 years ago to the present value of about 6 million tons of nitrogen per year. Similar emission trends of SO2 and NO sub x have taken place in North America. Sulfur dioxide emissions in Europe are predicted to remain about the same as present day emission through 1990. Further trends in emission will depend critically on the energy policies of each country and the entire region. Strong acids have decreased the mean annual pH of precipitation in much of Northwestern Europe and large areas of North America to between 4 and 4.5. The sources and environmental consequences of acid deposition NOTIN America to between 4 and 4.5. I he sources and environmental consequences of acid deposition are often separated by hundreds, even thousands, of kilometers. The emission source areas exposed to the heaviest depositions will be facing serious

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direct and indirect effects on natural ecosystems, materials and possibly even human health. Further, metal toxicity in soils, surface waters and ground-waters with consequences for terrestrial and aquatic life will most likely develop in both heavily polluted and sensitive areas. (Murphy-IVI) W84-03382

THE ROLE OF SOIL IN DETERMINING SUR-FACE WATER COMPOSITION, Macaulay Inst. for Soil Research, Aberdeen (Scot-

land). B. W. Bache.

Water Science and Technology, Vol. 15, No. 12, p 33-45, 1983. 6 Fig. 1 Tab, 21 Ref.

Descriptors: \*Soil properties, \*Surface water, \*Water properties, Chemical properties, Groundwater, Surface drainage, Rainfall impact, Mineralogy, Physiochemical properties.

The composition of major rivers and large lakes is variable within certain limits, and on a world scale follows a logical pattern controlled by the interplay of three mechanisms, atmospheric precipitation, rock dominance and evaporation-crystallization processes. Incoming precipitation in rural areas passes through soil and weathering rock during passage to surface waters. The composition of the effluent is determined by its hydrologic pathway and by the material through which it flows. Reactions between water and soils or weathering rocks are normally rapid compared with typical residence times, so that the composition of water is derived from the material through which it has passed. Composition data for groundtion of water is derived from the material through which it has passed. Composition data for ground-water, drainage and surface waters illustrate these principles. Apparent deviations are explained by low residence times or unusual catchment properties, and show that detailed mineralogical and physiographic information is important for catchments in sensitive areas, if the factors controlling water composition in these areas are to be understood. (Murphy, IVI) (Murphy-IVI) W84-03384

EFFECT OF RAIN ON SURFACE REAERA-

Asian Inst. of Tech., Bangkok (Thailand). R. B. Banks, G. B. Wickramanayake, and B. N.

Journal of Environmental Engineering, Vol. 110, No. 1, p 1-13, February, 1984. 4 Fig. 5 Tab, 9 Ref.

Descriptors: \*Aeration, \*Rain, \*Oxygen transfer, Turbulence, Rainfall rate, Air-water interfaces, Dissolved oxygen.

For any river or lake or other body of water, the atmosphere is the primary source of dissolved oxygen in the water. Any mechanism which creoxygen in the water. Any mechanism which creates turbulence at or near a water surface will tend to increase the rate of oxygen transfer across the surface. It seems apparent that rain falling on a body of water is a mechanism for the creation of surface turbulence. The energies of raindrops striking the water create cavities, droplets, and surface waves. This phenomenon was examined by conducting 108 laboratory experiments. Test variables were rainfall rate, rainfall or a mixing impact velocity, rotational velocity of a mixing impeller, and collector tank depth. The oxygen transfer conficient is directly proportional to the power of the rainfall. Heavy rainfalls over an extended the rainfall. Heavy rainfalls over an extended period of time may contribute significantly to the overall oxygen balance in a body of water. The direct addition of oxygen from raindrops with oxygen concentrations at or near the saturation concentration can be an appreciable fraction of the total amount of oxygen transferred as a consequence of the rainfall. (Moore-IVI) W84-03468

#### 2L. Estuaries

DISTRIBUTION AND ABUNDANCE OF ZOO-PLANKTON IN AN ALKALINE FRESHWATER MARSH IN NORTHUMBERLAND COUNTY, PENNSYLVANIA,

Bucknell Univ., Lewisburg, PA. Dept. of Biology. P. W. Seelbach, and W. F. McDiffett. Internationale Revue der Gesamten Hydrobiolo-gie, Vol. 68, No. 3, p 379-395, 1983. 9 Fig, 33 Ref.

Descriptors: \*Marshes, \*Zooplankton, \*Species diversity, Population dynamics, Distribution, Temperature effects, Acidity, Nitrogen, Phosphorus, Dissolved oxygen.

The zooplankton community of two ponds in an alkaline marsh in central Pennsylvania were studied. An open-water pond and an open-marsh pond were compared. The ponds were similar with respect to temperature, PJF, dissolved oxygen, total dissolved phosphorus, nitrate-nitrite nitrogen, and dissolved phosphorus, nitrate-nitrite nitrogen, ammonium nitrogen and chlorophyll a. They differed significantly with respect to conductivity, alkalinity, habitat type, vegetation, depth and predation pressure. The open water pond contained cladocerans, cyclopoid and calanoid copepods and rotters, all of which are common to open, limnetic waters. The nearby marsh pond contained cladocerans, cyclopoid copepods, ostracods and rottlers, all of which are common to littoral habitats. The marsh pond contained more species (35 to 25) than all of which are common to littoral habitats. The marsh pond contained more species (35 to 25) than the open water pond, but also supported lower population densities. The zooplankton communities of the two ponds were distinctly different from one another with regards to species, but similar when only zooplankton types are considered. (Baker-IV) W84-02956

SPATIAL DISTRIBUTIONS AND HYPOTHET-ICAL GRAZING PRESSURES OF ZOOPLANK-TON IN THE TIDAL, FRESHWATER POTO-MAC RIVER, American Univ., Washington, DC. Dept. of Biol-

ogy. C. Buchanan, and J. A. Schloss.

Journal of Freshwater Ecology, Vol. 2, No. 2, p 117-128, July, 1983. 4 Fig, 2 Tab, 27 Ref.

Descriptors: \*Zooplankton, \*Estuarine environ-ment, \*Potomac River, Tidal waters, Spatial distri-bution, Population dynamics, Stratification, Phyto-

Zooplankton in the tidal, freshwater Potomac River were studied to determine whether they could indeed stratify and undergo diel vertical migrations and what grazing pressures could be expected of zooplankton populations in the freshwater reach during the summer of 1981. Four working hypotheses emerged from the study. Zooplankton were usually unstratified due primarily to tidal mixing and they did not undergo the classic pattern of diel vertical migration. Under certain tidal and light conditions, some zooplankton species could stratify in deeper waters for short periods of time. Consequently, the mean vertical distribution of grazing pressure in the water column was bution of grazing pressure in the water column was slightly skewed toward the bottom. The horizontal slightly skewed toward the bottom. The horizontal distribution of zooplankton in the river was very patchy, and may be due to slow and uneven lateral diffusion of waters after entering the Potomac River. During the summer of 1981, zooplankton populations could hypothetically filter 1.1% to 3.7% of the river volume per day on the average. Grazing pressure was lowest in the Potomac River just below the fall line, at the Memorial Bridge station. Grazing was as high as 9.7%/day in the downstream end of the freshwater reach. (Baker-IVI)

DYNAMICS OF PHYSICAL AND CHEMICAL PARAMETERS IN OKEFENOKEE SWAMP, Louisville Univ., KY. Systems Science Inst

Journal of Freshwater Ecology, Vol. 2, No. 2, p 129-140, July, 1983. 9 Fig. 2 Tab, 12 Ref. NSF DEB 76-12292 and 78-08842.

Descriptors: \*Chemical properties, \*Physical properties, \*Okefenokee Swamp, \*Marshes, Oxygen, Organic compounds, Metals, Water level fluctuations, Temperature effects, Diurnal distribution,

During 1977 and 1978 diurnal and annual variations of physical and chemical parameters in a marsh within Okefenokee Swamp were examined. The general characteristics of physical and chemi-cal parameters in Okefenokee Swamp marshes were similar to other blackwater ecosystems. Conwere similar to other blackwater ecosystems. Con-centrations of dissolved metals are low while con-centrations of organic compounds are high. The water is usually acidic with a pH that varies be-tween 3.8 and 4.9. The water chemistry in the swamp is affected by the chemical, physical and biological factors which are dominant on different temporal scales. Climatic factors such as tempera-ture. Light and precipitation are probably the temporal scales. Climatic factors such as tempera-ture, light, and precipitation are probably the major driving forces operating on an annual basis in the marsh. Water level changes occur on an annual scale because of changes in precipitation, evapotranspiration, inflows and outflows. Calcium, magnesium, and potassium ions are strongly corre-lated with water levels. During droughts, when water levels are near zero, the marsh environment water levels are near zero, the marsh environment is drastically altered. Oxygen falls to concentrations near zero, while other elements are elevated. tions near ze (Baker-IVI) W84-02968

MANGROVE DISTRIBUTION IN NORTH-WESTERN AUSTRALIA IN RELATIONSHIP TO REGIONAL AND LOCAL FRESHWATER SEEPAGE.

V. Semeniuk

Vegetatio, Vol. 53, No. 1, p 11-31, July, 1983. 12 Fig, 7 Tab, 25 Ref.

Descriptors: \*Mangrove swamps, \*Tidal flats, Australia, Hydrology, Seepage, Natural waters, Salinity, Groundwater properties, Stratigraphy.

The field studies conducted illustrate the relationship between mangrove distribution and a variety of physico-chemical factors such as tidal flat of physico-chemical factors such as tidal flat groundwater, freshwater input, and stratigraphy. The tidal flat stratigraphy is important in its relationship to the hinterland groundwater system and to hinterland drainage patterns, be they surface or internal types. It is this hinterland/tidal-flat stratigraphy that influences freshwater discharge into tidal lands and so has a marked effect on mangrove species distribution. Climate per se is important in that it may provide a short, intense, direct freshwater input and secondity it may resulted evaporation. that it may provide a short, intense, direct freshwa-ter input and secondly it may regulate evaporation on the high tidal flats. However, long-term fresh-water input flowing for most of the dry season will be a far more effective and influential control on be a lar more effective and influential control on mangrove distribution. A freshwater reservoir lies within the hinterland, but the fresh water requires pathways through which it can invade hypersaline groundwater fields if it is to influence mangrove distribution. Analysis of the stratigraphic/hydrologic framework is therefore of importance to understanding mangrove development and zonation, particularly along the landward fringe, because it provides the key to understanding mechanisms of these subterranean freshwater incursions. (Baker-172) W84\_02972

GRADIENT ANALYSIS OF THE VEGETATION OF THE BYRON-BERGEN SWAMP, A RICH FEN IN WESTERN NEW YORK,

Ithaca Coll., NY. Dept. of Biology. J. M. Bernard, F. K. Seischab, and H. G. Gauch,

Vegetatio, Vol. 53, No. 2, p 85-91, September, 1983. 4 Fig. 1 Tab, 24 Ref. NJF Grant DED-7809340.

Descriptors: \*Vegetation, \*Fens, \*New York, \*Byron-Bergem Swamp, Species diversity, Detrended correspondence analysis, Soil properties, Organic matter, Peat, Marl, Hummocks, Swamps.

Transects of contiguous one square meter quadrats were sampled across the marl and peat mosaic of the Byron-Bergen swamp, a rich fen in western New York. The data were analyzed by detrended correspondence analysis (DCA). The ordination successfully separated sedge fen from marl fen vegetation in spite of the high beta diversity (6.99) and further separated hummock from encroaching

### Estuaries—Group 2L

forest sites. Neither of these separations was ac-complished by alternative ordination techniques. Detrended correspondence analysis offers a signifi-cant advantage over reciprocal averaging and ear-lier ordination techniques for the study of within-and between-community pattern because of its su-perior performance with long vegetation gradients (more than 4 or 5 half-changes as observed in this study and indicated by the high beta diversity shown). DCA serves to convert species composi-tion data into a vegetational variable whose pat-terns can then be compared with environmental patterns in order to generate hypotheses about the patterns in order to generate hypotheses about the causes of within-community vegetation patterns. (Baker-IVI)

ENVIRONMENTAL GRADIENTS AND BENTHIC MACROINVERTEBRATE DISTRI-BUTIONS IN A SHALLOW NORTH CAROLI-NA ESTUARY, National Marine Fisheries Service, Beaufort, NC.

Beaufort Lab.

Beauth Lab.

A. J. Chester, R. L. Ferguson, and G. W. Thayer.

Bulletin of Marine Sciences, Vol. 33, No. 2, p 282-295, April, 1983. 6 Fig. 7 Tab, 42 Ref.

Descriptors: \*Estuarine environment, \*Benthos, Aquatic life, Invertebrates, North Carolina, Estu-aries, Distribution, Sediments, Tidal effects.

Environmental gradients and distributional pat-terns of benthic macroinvertebrates were studied using multivariate statistical analyses in subtidal sediments of a shallow, southeastern United States sediments of a shallow, southeastern United States estuary. Along a major estuarine gradient from fine anaerobic sediments, rich in organic matter and pheopigment to coarse aerobic sediments high in ATP and chlorophyll biomass and numbers of individuals increased significantly. A second environmental gradient within the lower estuary linked high numbers of invertebrates to depositional areas near salt marshes and low numbers to turbulent regions adjacent to deep, tidally-scoured channels. Invertebrate species composition was spatially associated with both environmental gradients. Seasonal patterns of abundance and biomass varied in sonal patterns of abundance and biomass varied in the estuary, possibly due to differential predation on the dominant species. The observed sediment distributions were consistent with results of earlier studies. (Baker-IVI)

NICKEL TOXICITY TO ESTUARINE/MARINE FUNGI AND ITS AMELIORATION BY MAGNESIUM IN SEA WATER,
New York Univ., NY. Lab. of Microbial Ecology.
For primary bibliographic entry see Field 5C.
W84-02988

FRESHWATER IMPACTS IN NORMALLY HY-PERSALINE MARSHES, San Diego State Univ., CA. Dept. of Biology. J. B. Zedler. Estuaries, Vol. 6, No. 4, p 346-355, December, 1983. 4 Fig. 4 Tab, 13 Ref. NOAA grant NA80AA-D-00120.

Descriptors: \*Salt marshes, \*Floodwater, \*Rainfall, Marshes, Saline water, Environmental effects, Flooding, Saline soils, Biomass, Halophytes, California, Tijuana Estuary, Los Penasquitos Lagoon,

Southern California salt marshes usually have hypersaline soils, but heavy rainfall in 1978 and 1980 caused flooding. Freshwater effects were correlated with the degree of change in soil salinity. At Tijuana Estuary (1980), a short-term reduction in the salinity of normally hypersaline soils was followed by a 40% increase in the August biomass of Spartina folliosa. At Los Penasquitos Lagoon (1978), a longer period of brackish water influence was followed by a 160% increase in August biomass of Salicornia virginica. At the San Diego was followed by a follow increase in August offi-mass of Salicornia virginica. At the San Diego River (1980), flood flows were augmented by major reservoir discharge. Continuous freshwater flow leached most of the marsh soil salts and caused replacement of halophytes by freshwater marsh species. The first two cases fell within the

normal range of flooding events, even though the hydrology of both watersheds has been modified. The vegetation response was functional. The productivity increased but there was no major change in species composition. The vegetation rapidly returned to preflood conditions. However, the long-term freshwater flow in the San Diego River was unnatural. Floral composition changed as soils were leached of salts. Recovery following the return of saline soils has been slow because many native halophytes are not good colonizers. Southreturn of saline soils has been slow because many native halophytes are not good colonizers. Southern California salt marshes are resilient to flooding, but artificially prolonged flooding can cause shifts in composition from which the marsh will recover slowly if at all. Management for the maintenance of natural salt marsh communities must include management of the watershed's hydrology so that the timing and duration of fresh water discharges do not exceed the threshold for compositional changes. (Murphy-IVI) W84-03036

#### TRANSIENT HYDRODYNAMIC AND SALINITY SIMULATIONS IN THE CHESAPEAKE BAY NETWORK,

Thatcher Research Associates, Inc., Palisades, NY. M. L. Thatcher, and T. O. Najarian. Estuaries, Vol. 6, No. 4, p 356-363, December, 1983. 7 Fig, 2 Tab, 20 Ref.

Descriptors: \*Salinity, \*Bays, Saline water intrusion, Estuaries, Harbors, Chesapeake Bay, Model studies, Atlantic Ocean, Tidal hydraulics.

The temporal and spatial variations of salinity in upper Chesapeake Bay and its tributaries are of interest to water resource planners. Many characteristic estuarine processes are related to the salinity gradients in the system. Also, such gradients affect the magnitude of the non-tidal circulation in estuaries and partially determine the spatial distribution of the resident fauna and flora in the system. Calibration of a model was based on only three external parameters: a friction factor that was spatially described, and two global constants required to calibrate a dynamic dispersion relationship that depended on both the local salinity gradient and hydraulic conditions. The transient hydrodynamics and the transient salinity distribution of the Bay and its tributary estuaries were simulated for the period of one month and comparisons were made period of one m period of one month and comparisons were made between calculated and observed salinities. The between calculated and observed salinities. The dynamics of salt transport in the Bay proper are sensitive to local freshwater inflows. The simulations of salinity during August-September 1969 indicate that, whereas salinities in the lower Bay have an initial decreasing trend due to large freshwater inflows, the trends in the upper Bay are increasing due to the low freshwater inflows from the Susquehanna River during this period. It was not possible to fully verify the capability of the model in simulating the transport of sea salts from the Bay to the tributary estuaries, due to the lack of synoptic data on the salinity concentrations in the tributaries. (Baker-IVI) W84-03037

THE REPRODUCTIVE CYCLE OF THE BAY SCALLOP, ARGOPECTEN IRRADIANS IRRADIANS (LAMARCK), IN A SMALL COASTAL EMBAYMENT ON CAPE COD, MASSACHU-SETTS.

SET1S,
Woods Hole Oceanographic Institution, MA.
R. E. Taylor, and J. M. Capuzzo.
Estuaries, Vol. 6, No. 4, p 431-435, December,
1983. 4 Fig. 1 Tab, 17 Ref. NOAA grant
NA80AA-D-00077.

Descriptors: \*Estuarine environment, \*Scallops, \*Massachusetts, \*Cape Cod, Shellfish, Hydrology, Spawning, Estuarine fisheries, Water temperature.

Because of its economic importance to coastal Because of its economic importance to coastal communities, an understanding of the dynamics of bay scallop populations is necessary for protection and for effective management of the fishery. The spawning activity of the bay scallop A. irradians irradians was monitored from May through September (1979) in a small embayment on Cape Cod, Massachusetts and compared with changes in hydrographic conditions. Spawning activity of bay

scallops began in May and continued through July with some minor activity occurring during August and September. Activity was related to changes in ambient temperature and occurred predominantly before the summer maximum temperatures. As temperatures declined in the late summer and early fall, there was increased gametogenic activity. There was a longer period of spawning activity than previously reported for New England waters. (Murphy-IVI)
W84-03039

OBSERVATION OF EPISODIC SEDIMENTA-TION IN A TIDAL INLET (SABINE PASS, TEXAS AND LOUISIANA),

Espey, Huston and Associates, Inc., Austin, TX. G. H. Ward, Jr.

The Texas Journal of Science, Vol. 35, No. 2, p 101-108, July, 1983. 3 Fig, 7 Ref.

Descriptors: \*Episodic sedimentation, \*Tidal inlet, \*Sabine pass, Sedimentation, Tidal effects, Hydrometeorology, Coastal waters, Sedimentation rates, Sediment yield.

Sediment transport is not a constant process, but highly time variable and probably episodic, being dictated by such transient factors as tidal phase, wave climate, and the hydrometeorological regime. The sedimentation monitored with a recording tipping-bucket sampler in Sabine Pass, the inlet connecting Sabine lake (on the Texas-Louisiana boundary) and the Gulf of Mexico was episodic characterized have contacted in the contact of the co ana bouncary) and the Guit of Mexico was episodic, characterized by events widely spaced in time. There was no apparent relation to astronomical tide, even at maximum declination. Sedimentation tended to be dictated by hydrometeorological factors. The most intense sedimentation episode of the study period (October and November 1978) was associated with the most energetic frontal pas (Murphy-IVI) W84-03107

CHEMISTRY OF DISSOLVED AND PARTICU-LATE MATERIAL IN THE ESTUARY OF THE RIMOUSKI RIVER (CONTRIBUTION A L'ETUDE CHIMIQUE DU MATERIEL DIS-SOUS ET PARTICULAIRE DE L'ESTUAIRE DE LA RIVIERE RIMOUSKD,

Quebec Univ., Rimouski. Dept. of Oceanography. N. Belzile, and J. Lebel.

Marine Chemistry, Vol. 13, No. 1, p 15-34, 1983. 13 Fig, 2 Tab, 48 Ref.

Descriptors: \*Chemical analysis, \*Particulate matter, \*Estuaries, \*Rimouski River, Alkalinity, Pollution load, Natural flow, Residual chlorine, Fate of pollutants

Suspended particulate matter (SPM) in the Rimouski River estuary contained dissolved oxygen, silicate, nitrate, phosphate, Mn, Fe and Al. At any given time, total alkalinity (TA) is conservative within the estuary with respect to chlorinity. The TA of the freshwater is related to river flow. This is attributed to dilution of the river water with bicarbonate-poor rainwater. Generally, pH follows the same pattern observed for TA in freshwater. Dissolved oxygen is usually more concentrated in freshwater and decreases linearly with increasing chlorinity. Freshwater is always saturated or supersaturated with respect to O2. Seasonal fluctuations are attributed to temperature variations. There is no evidence for removal of soluble silicate from the freshwater entering the sea. The concentrom the freshwater entering the sea. The concentrom the freshwater entering the sea. from the freshwater entering the sea. The concentration of silicate in the freshwater is strongly influenced by rainfall. Soil leaching, conditioned by high rainfall increases the concentration of soluble silicate in freshwater. Nitrate behaves similarly ble sticate in freshwater. Nitrate behaves similarly whereas phosphate is complicated by the presence of sewage. The Mn, Fe and Al contained in the SPM indicates dilution of river-borne particles rich in Mn by others less rich in this element. A decrease in Mn content with increasing chlorinity and SPM concentration as well as increasing con-centrations of SPM with increasing chlorinity indicate that the composition is controlled primarily by physical mixing of material from two sources rather than by chemical processes. Within the anaTHE NATURE RESERVE S'GRAVENDEL (RETIE, BELGIUM); I. PHYTOSOCIOLOGICAL DESCRIPTION IN RELATION TO MOISTURE AND SOIL CONDITIONS (HET NATURGEBIED 'S-GRAVENDEL (RETIE, ELGIE; I, FITOSOCIOLOGISCHE BESCH-RIJVING IN RELATIE TOT VOCHTIGHEID EN RODEMO

Antwerp Univ., Wilrijk (Belgium). Dept. of Biol-

ogy.

D. Paelinckx, and R. Soetiens.

Bulletin de la Societe Royale de Botanique de Belgique, Vol. 116, No. 1, p 74-92, 1983. 3 Fig, 7 Tab, 22 Ref.

Descriptors: \*s'Gravendel Nature Reserve, \*Belgium, \*Soil water, \*Plant communities, Marshes, Heaths, Soil nutrients, Flooding, Minerals, Wet-

s'Gravendel is a marshy heath of 11 ha in the northwest of the Campine-district. Strong differences in intensity of earlier flooding with channel-mater, rich in minerals, and smaller or larger differences in height cause a complex system of gradients in moisture and nutrient content. We find elements of the Magnocaricion in the wetter and more estrophic parts of the area. Littorellion-communities occupy the other pools while the dryer ground is covered by Erica and Myrica heaths. (Author's abstract)

NITROGEN LOSSES FROM A LOUISIANA GULF COAST SALT MARSH, Louisiana State Univ., Baton Rouge. Center for

Wetland Resources.
R. D. DeLaune, C. J. Smith, and W. H. Patrick, Jr. Estuarine, Coastal and Shelf Science, Vol. 17, No. 2, p 133-141, August, 1983. 6 Tab, 17 Ref.

Descriptors: \*Salt marshes, \*Nitrogen, Louisiana, Gulf Coast, Estuarine environments, Coastal waters, Spartina alterniflora, Nitrogen cycle, Am-monium, Nitrification.

Nitrogen has been identified as the most important nutrient in regulating wetland macrophyte produc-tion. Ammonium is the predominant form of inor-ganic N found in the saturated sediment. Losses of ganic N found in the saturated sediment. Losses of N-15 labeled nitrogen were measured in a Spartina alterniflora salt marsh over three growing seasons. Labelled NH4(+)-N equivalent to 100 micrograms N/g of dry soil was added in four installments over an eight week period. Recovery of the added nitrogen ranged from 93% 5 months after addition of the NH4(+)-N to 52% at the end of the third reviews assoon. This represented a nitrogen loss growing season, This represented a nitrogen loss equivalent to 3.4 g N/sq m. By calculating the rate of mineralization it was possible to estimate the availability of the labelled NH4(+)-N incorporatavailability of the labelled NH4(+)-N incorporated into the organic fraction. The time required for mineralization of 1% of the tagged organic N increased progressively with succeeding cuttings of the S. alterniflora and ranged from 152 to 299 days. Only 2% of the nitrogen applied at N-15 labelled plant material to the marsh surface in the fall could be accounted for in S. alterniflora the following season. The findings of this study substantiate previous nitrogen studies conducted in this Louisiana Gulf Coast salt marsh. (Baker-IVI) W84-03190

PLANKTON PRODUCTIVITY AND BIOMASS IN A TRIBUTARY OF THE UPPER CHESA-PEAKE BAY. I. IMPORTANCE OF SIZE-FRAC-TIONATED PHYTOPLANKTON PRODUCTIV-ITY, BIOMASS AND SPECIES COMPOSITION IN CARBON EXPORT, Academy of Natural Sciences of Philadelphia, Benedict, MD. Benedict Estuarine Research Lab.

K. G. Selli

Estuarine, Coastal and Shelf Science, Vol. 17, No. 2, p 197-206, August, 1983. 1 Fig. 5 Tab, 37 Ref.

Descriptors: \*Plankton, \*Primary productivity, \*Bays, Estuarine environments, Coastal waters,

Chesapeake Bay, Phytoplankton, Carbon, Nanoplankton, Estuaries, Zooplankton, Cyanophyta.

Brackish-water tributaries are very productive with high planktonic productivity and faily exten-sive marsh communities supplying nutrients and organic matter. The contributions of inflowing or-ganic matter and nutrients to the bay could con-ceivably lead to more eutrophic conditions for this large draines system if the particulate materials cervany lead to more eutropine condutions for this large drainage system if the particulate materials are not utilized within the tributaries. Brackish waters of the lower Gunpowder River, a tributary of the Chesapeake Bay were the site of a 9 month study of phytoplankton productivity, community composition and biomass. Primary productivity followed expected seasonal magnitudes for temperature of the control followed expected seasonal magnitudes for temperate estuaries with rates exceeding 142.4 mg C/cubic m/hr in July through September of 1979. Minimum rates of 1.6 mg C/cu m/hr were noted in February of 1980. Annual primary production was estimated at 45.5 g C/sq m. Cyanophytes dominated the planktonic algae with cell numbers being highest in August, September and November. Nanoplanktonic forms dominated the primary productivity, chlorophyll concentrations and cell desnties throughout the study. Phytoplankton carbon calculated from cells volumes exceeded nutritional requirements of the pelagic herbivores in all months suggesting a mean daily export of 1607 mg C/cubic m/day to the bay or sediments. Thus the upper Chesapeake Bay may receive significant carbon influx as ungrazed phytoplankton cells, including high densities of procaryotic blue-green lagae, from the lower Gunpowder River estuary. The fates of the ungrazed carbon and in particular the high procurated features in the contraction of the pelagities in Chesapeak. The fates of the ungrazed carbon and in particular the high procaryote densities in Chesapeake Bay remain to be determined. (Baker-IVI)

REDUCED RATES OF PRIMARY PRODUC-TION IN THE COLUMBIA RIVER ESTUARY FOLLOWING THE ERUPTION OF MT. SAINT HELENS ON 18 MAY 1980, Oregon State Univ., Corvallis. School of Oceanog-

R. E. Frey, J. R. Lara-Lara, and L. F. Small. Estuarine, Coastal and Shelf Science, Vol. 17, No. 2, p 213-218, August, 1983. 1 Fig, 2 Tab, 10 Ref.

Descriptors: \*Environmental effects, \*Primary productivity, \*Columbia River Estuary, \*Mt. Saint Helens, \*Turibidity, \*Volcanoes, Plankton, Columbia River, Phytoplankton, Light intensity, Light penetration.

A massive increase in suspended particulate material in the Columbia River Estuary resulted from the eruption of Mt. Saint Helens on 18 May of 1980 cruption of Mt. Saint Helens on 18 May of 1980 causing a substantial increase in light attenuation. Photosynthesis, being partly controlled by the depth of light penetration into the water, was reduced by about 75% during the period of increased turbidity. After about five weeks time the estuary was somewhat cleared. During this period the primary productivity in the estuary water column was greatly diminished. However, the flux column was greatly diminished. However, the flux of particulate carbon through the estuary was high. The total production estimated to have been lost amounted to only about 2% of the total particulate carbon flux just after the eruption. That the high levels of turbidity in the estuary did not induce a severe fall in the phytoplankton population is evidence that phytoplankton biomass concentrations in the Columbia River Estuary are mostly a function of import from the Columbia River, rather than a function of in situ production. Concentrations of organic sestion, particulate carbon, and tions of organic seston, particulate carbon, and particulate nitrogen were all higher just after the eruption than during cruises!—month earlier and 2— months later. This indicates that suspended sedi-ment added to the estuary as a result of the eruption contained substantial quantities of organic matter. The food value of this material to estuarine organisms is not known. (Baker-IVI) W84-03201

FLUORIDE POLLUTION IN FRENCH RIVERS AND ESTUARIES.

Ecole Normale Superieure, Paris (France). Lab. de J.-M. Martin, and F. Salvadori.

Estuarine, Coastal and Shelf Science, Vol. 17, No. 3, p 231-242, September, 1983. 11 Fig. 2 Tab, 23 Ref. C.N.E.X.O. Grants 78/1937 and 79/2102.

Descriptors: \*Fluoride, \*Estuaries, \*Rivers, France, Seine River, Gironde River, Charente River, Industrial wastes, Particulate matter, Loire

Fluoride has long been considered as an acute pollutant to natural environment because of the ability of plants and marine organisms to accumulate it and because of its detrimental effects upon aquatic biota which can be affected by concentrations as low as 1.5 mg/l. The unpolluted estuary in the Loire has been compared with the Seine, Gironde and Charente where important discharges occur. Natural dissolved concentration can be multiplied by a factor of 30. In the Seine estuary fluorine particulate concentration reached almost 2000 ppm. Anthropic discharge did not influence the percentage between free and complexed discharge of fluoride. The present French rivers discharge of fluoride is 700% higher than the pristine value. At a global scale, dissolved fluoride has probably increased by 25% compared with the natural situation. (Baker-IVI) W84-03202

TURBULENCE MEASUREMENTS IN STRATIFIED AND WELL-MIXED ESTUARINE FLOWS,

Hydraulics Research Station, Wallingford (England).

H. O. Anwar. Estuarine, Coastal and Shelf Science, Vol. 17, No. 3, p 243-260, September, 1983. 13 Fig, 1 Tab, 30 Ref.

Descriptors: \*Turbulence, \*Estuarine environ-ment, Stratification, River Carron, Scotland, Ve-locity, Salinity, Buoyancy, Energy, Tidal currents, Flow characteristics, Stratified flow.

Velocity distributions were shown to be log-linear in stratified flows and logarithmic in well-mixed flows using mean velocities measured in estuarine flows. The mean salinity profiles are geometrically self-similar and expressible by a power-law. The drag coefficient remains constant at about .0032 in stratified case and is time dependent in well-mixed flow. The gradient and the flux Richardson numflow. The gradient and the flux Richardson num-bers are almost equal, varying between 0.06 and 0.12, and independent of the flow state. The Monin-Obukhov length-to-depth ratio varies be-tween 0.08 and 0.29. The non-dimensional parame-ter describing dissipation rates of turbulent kinetic energy remains a constant of about 0.2 and 0.3 for stratified and well-mixed flows, respectively. The nondimensional vertical turbulence coefficient varies between 0.5 and 1.7. The shape of the turbu-lent energy spectra and co-spectra of longitudinal lent energy spectra and co-spectra of longitudinal and vertical velocity fluctuations in stratified flows are broader, and their maxima are lower than those of well mixed flows. (Baker-IVI) W84-03203

APPLICATION OF NITROGEN-CYCLE MODEL TO MANASQUAN ESTUARY, T. O. Najarian, P. J. Kaneta, J. L. Taft, and M. L.

Journal of Environmental Engineering, Vol. 110, No. 1, p 190-207, February, 1984. 10 Fig, 3 Tab, 16

Descriptors: \*Nitrogen cycle, \*Manasquan Estu-ary, \*New Jersey, \*Estuarine environment, Mathe-matical models, Water quality, Hydrodynamics, Trophic level, Simulation.

A refined version of an ecologic and water quality mathematical model is applied to a small Atlantic coast estuarine network. The temporal and spatial variations in the water quality of the system are examined through the analysis of the nitrogen cycle developed for estuarine environments. The model is best on the water convention of alexance. model is based on the mass conservation of elemen-tal nitrogen in its various biotic and abiotic states. The ecologic model structure contains two trophic levels: primary producers, and herbivorous cope-

#### WATER SUPPLY AUGMENTATION AND CONSERVATION—Field 3

#### Use Of Water Of Impaired Quality-Group 3C

pods. A concerted effort is made to derive realistic pods. A concerted effort is made to derive realistic model-governing transformations and rate parameters. The hydrodynamic and water quality model simulations are calibrated and verified using shorterm, transient data gathered in the Manasquan Estuary and Point Pleasant Canal. Model verification for abiotic constituents of the nitrogen cycle is achieved, with biotic constituents verification needing more detailed field data. Model results show the influence of transport processes on the temporal and spatial distribution of nitrogen-cycle constituents in the network examined. (Author's abstract) stract) W84-03476

#### 3. WATER SUPPLY AUGMENTATION AND CONSERVATION

#### 3B. Water Yield Improvement

AUGMENTATION OF RAINFALL FROM SUMMER CUMULUS CLOUDS,

Bureau of Reclamation, Denver, CO. Div. of Atmospheric Resources Research.
A. S. Dennis.

Agricultural Water Management, Vol. 7, No. 1-3, p 3-14, 1983. 3 Fig. 5 Tab, 24 Ref.

Descriptors: \*Cloud seeding, \*Cumulus clouds, \*HIPLEX, Rainfall, Weather modification, Rainfall augmentation, High Plains, Montana, Cloud development, Dry ice.

The latest round of field experiments related to augmentation of rainfall from summer cumulus clouds over the Great Plains is described briefly. HIPLEX (High Plains Cooperative Program) was designed to reduce scientific uncertainty associated designed to reduce scientific uncertainty associated with attempts to increase rainfall by cloud seeding in the High Plains. Field programs were conducted at three sites. A randomized experiment, HIPLEX-1, was set up in Montana to test a physical hypothesis linking dry ice seeding to rainfall from cloud base. HIPLEX has confirmed the importance of ice processes to precipitation formation in cumulus clouds of the High Plains and the dominance of ciouds of the High Plains and the dominance of mesoscale convergence/divergence fields on convective cloud development. HIPLEX-1 clearly showed increases in cloud ice concentrations associated with dry ice seeding 2 and 5 min after treatment time. Some changes in the subsequent steps in the physical hypothesis linking seeding to increased rainfall at cloud base are indicated but cannot be firmly established with the present data set. (Author's abstract)
W84-03448

UTILIZATION AND ASSESSMENT OF OPERATIONAL WEATHER MODIFICATION PROGRAMS FOR AUGMENTING PRECIPITA-

Colorado State Univ., Fort Collins. Dept. of At-

Colorado State Chirv., Post Colamba Legamospheric Science.
L. O. Grant.
Agricultural Water Management, Vol. 7, No. 1-3, p 23-35, 1983. 1 Fig, 12 Ref.

Descriptors: \*Weather modification, \*Assessment, Cost-benefit analysis, Cloud seeding, Rainfall augmentation, Precipitation, Statistical analysis.

There have been and continue to be a significant There have been and continue to be a significant number of operational weather modification programs for augmenting water supplies. The benefit to cost relationship for such programs is very favorable if even only modest changes in precipitation are produced. The incentive for these programs is particularly strong in the drier, western parts of the country and in all areas during drought periods. Evaluations and assessments are needed in any specific region to both confirm and establish the amount of precipitation changes and to provide the amount of precipitation change and to provide the basis for improvement in program performance. Interacting factors which must be considered in evaluation or assessing weather modification programs include aspects relating to the organizational, legal, assessment and integration components of such programs. Technical assessment

should include assessment related to the operational efficiency of the program, physical studies to verify the occurrence of the chain of events expected from the seeding hypothesis employed, and statistical analyses to establish the changes in precipitation. Physical analyses by independent researchers superimposed on operational programs provide an unique opportunity to facilitate scientific research at less cost and provide significant technical input to the operational program. In such piggy back research efforts, the pertinence of the findings to the operational program is direct, and piggy back' research efforts, the pertinence of the findings to the operational program is direct, and the cost to the research can be significantly less. Randomization is highly desirable, but if full randomization is not acceptable, some compromises are feasible that can still permit scientific integrity of the analysis. (Moore-IVI) W84-03449

SOIL MANAGEMENT FOR SEMIARID RE-

GIONS, Minnesota Univ., St. Paul. Dept. of Soil Science. For primary bibliographic entry see Field 3F. W84-03450

## 3C. Use Of Water Of Impaired

USING RLOWDOWN WATER TO IRRIGATE CROPS, California Univ., Riverside. Dept. of Soil and En-

Cantorna Univ., Riverside. Dept. of Soil and Environmental Sciences. W. A. Jury, L. H. Stolzy, C. A. Fox, H. J. Vaux, Jr., and I. R. Straughan. California Agriculture, Vol. 37, No. 3 and 4, p 4-5, March-April, 1983. 4 Tab.

Descriptors: \*Irrigation water, \*Cooling water, Powerplants, Water reuse, Water conservation.

The reuse of power plant cooling water for crop irrigation was examined for a period of 7 years. The first 3 years of study were conducted in 28 soil lysimeters containing four representative soil types from California. Alternate crops of winter wheat and socialize the recovery using three levels of and sorghum were grown using three levels of total dissolved salts, 1,500, 3,000 and 6,500 ppm, which are within the range expected to be found in blowdown. Since the irrigation setup is so much less expensive to construct and maintain than a lined evaporation pond, this method of disposal could save a considerable amount of money. In the arid Southwest, more exotic crops, such as jojoba, guayule, and mesquite, may also be profitable when irrigated with blowdown water. (Baker-IVI)

FERTILIZER AND SALTY WATER EFFECTS ON PHASEOLUS, Cornell Univ. Agricultural Experiment Station, Ithaca, NY. Dept. of Agronomy.
R. J. Wagenet, R. R. Rodriguez, W. F. Campbell, and D. L. Turner.
Agronomy Journal, Vol. 75, No. 2, p 161-166, March-April, 1983. 7 Tab, 23 Ref.

Descriptors: \*Fertilization, \*Saline water, \*Pha-seolus, Legumes, Saline soils, Irrigation effects, Nutrients, Nitrogen, Phosphorus, Irrigation man-agement, Crop yield.

The response of legumes such as Phaseolus to adverse salt or water regimes is relatively unstudied as a function of soil nutrient status. Greenhouse studies, involving interactive effects on snap bean (P. vulgaris L.) yield of three levels of irrigation water salinity, three frequencies of irrigation water application, two levels of N applied in the irrigation water, and seven levels of P and K fertilization, determine if the adverse effects of saline conditions or water stress on Phaseolus could be conditions or water stress on Phaseolus could be overcome by enhanced fertility status and/or improved saline water management on an Argixeroll. Dry matter and bean yields were reduced with Dry matter and bean yields were reduced with decreasing irrigation frequency (2 to 8 days) and increasing salinity of irrigation water (0.5 to 8.0 mmho/cm). Percentage yeild decrements were measured for both salt and irrigation regimes. Yield increases were noted for all fertilizer treat-

ments so long as salinity did not become too high (8 mmho/cm). Plant N content and root weight were responsive to irrigation frequency and salinity, but not to fertilizer form. Nitrogen applied in the irrigation water produced increased yield across all treatment in one set of experiements where greenhouse conditions were hot, dry, and of high potential evapotranspirational demand. No N effect was measured in a second series of experiments with low potential ET. (Murphy-IVI) W84-03239

EFFECTS OF WASTEWATER IRRIGATION AND PLANT AND ROW SPACING ON SOY-BEAN YIELD AND DEVELOPMENT,

Michigan State Univ., East Lansing. Dept. of Crop and Soil Sciences. M. J. Cordonnier, and T. J. Johnston.

Agronomy Journal, Vol. 75, p 908-913, November-December, 1983. 1 Fig. 5 Tab, 16 Ref.

Descriptors: \*Wastewater irrigation, \*Irrigation effects, \*Cultivation, \*Soybean yield, Municipal wastewater, Dry matter, Chemical analysis, water

Considerable research has demonstrated that soy-bean 'Glycine max (L.) Merr.' yields can be in-creased with the addition of supplemental water during reproductive stages, but little information is available concerning the use of municipal available concerning the use of municipal wastewater as the water source. Variables included wastewater as the water source. Variables included in this field study were: three water regimes-municipal wastewater, well water and no water; two row spacings-51 and 76 cm; two in-row spacings-20 and 32 plants/m and two cultivars-Nebsoy and Harcor. Soybeans planted on a Miami silt loam soil (fine-loamy, mixed, esic Typic Hapludalf) received a total of 9.8 cm of wastewater or well water as exceptional control of the solution overhead spray irrigation in 1979 and 9.4 cm in 1980. Seed yields were significantly different for water treatments in 1979 with 2,430, 2,580, and 2,700 ke/fee for a possible to the second se water treatments in 1979 with 2,430, 2,580, and 2,790 kg/ha for no water, well water and wastewater, respectively. Yields generally increased as plant population increased with the fighest plant population (645,500 plants/ha). Irrigated plants were 4 to 5 cm taller, matured 5 to 6 days later, had larger seeds and lodge slightly more than nonirrigated plants. The two cultivars responded differently to the wastewater, with Harcor exhibiting a better response than Nebsoy. The 1980 growing season was wetter than normal The 1980 growing season was wetter than normal and there was little or no yield response to irrigation. Under the conditions of soil type, climate and wastewater quality found during this experiment, wastewater was generally superior to well water in increasing yields. (Murphy-IVI) W84-03271

LEACHING REQUIREMENT FOR SALINITY CONTROL III. BARLEY, COWPEA, AND CELERY,

Agricultural Research Service, Riverside, CA. Salinity Lab.

G. J. Hoffman, and J. A. Jobes. Agricultural Water Management, Vol. 6, No. 1, p 1-14, 1983. 4 Fig, 4 Tab, 10 Ref.

Descriptors: \*Leaching requirement, \*Barley, \*Cowpea, \*Celery, \*Salinity, Crop yield, Irrigation, Evapotranspiration.

Leaching requirement, the smallest steady-state leaching fraction which prevents any loss in crop yield, was determined for barley, cowpea, and celery in field plots at the U.S. Salinity Laboratory. Six replicated leaching-fraction testings. celery in field plots at the U.S. Salinity Laboratory. Six replicated leaching-fraction treatments were irrigated many times each day with small quantities of water having an electrical conductivity of 2.3 dS/m. The crops were grown in succession between January 1979 and September 1981. The leaching requirement (Lr) was 0.10 for barley grain and 0.13 for barley forage. For cowpea seed, Lr was 0.16, 0.17 for cowpea forage, Lr for celery was 0.14. These experimentally determined values for barley and cowpea seed are higher by about 0.05 than those predicted by a leaching-requirement model based on an exponential crop water-uptake pattern. The experimental values for celery

#### Field 3—WATER SUPPLY AUGMENTATION AND CONSERVATION

#### Group 3C-Use Of Water Of Impaired Quality

and cowpea forage are lower than predicted values by 0.06. These differences are not considered sig-nificant, however, when considered in terms of the small differences in water applications (about 25 mm) to cause these changes in Lr. Evapotranspiration during each crop's growing season coincident with Lr was 410, 630, and 460 mm for barley, cowpea, and celery, respectively. (Author's ab W84-03431

#### 3F. Conservation In Agriculture

RESIDUE MANAGEMENT AND CULTURAL PRACTICES FOR A SEMIARID REGION, Agricultural Research Service, Big Spring, TX.

J. D. Bilbro, and D. W. Fryrear. Journal of Soil and Water Conservation, p 312-314, May-June, 1983. 6 Ref.

Descriptors: \*Water conservation, \*Erosion control, \*Residue management, \*Semiarid lands, Cropresidues, Infiltration, Soil erosion, Agricultural runoff, Wind erosion, Mulches, Cotton, Grasses.

In many regions of the United States, crop residue, if properly managed, can greatly minimize wind and water erosion and increase infiltration of preif properly managed, can greatly minimize wind and water erosion and increase infiltration of precipitation. The use of applied mulches and residue grown in-place in the blank rows of the planting pattern of two rows of cotton alternated with two blank rows, and the use of perennial plants as wind barriers a top small, parallel terraces are two types of residue management. Three tons/acre of cotton gin trash and 4.5 tons/acre of millet residue applied as mulches to the blank rows of a two by two pattern in 1982 increased cotton lint yields by 47 lbs/acre, a 24% increase and 144 lbs/acre (90%), respectively. Additional quantities of either mulch did not significantly increase lint yields. Growing either millet or pigweeds in the blanks of a two by two pattern in 1982 reduced lint yields drastically and by essentially the same amounts, regardless of whether the millet and pigweeds were mowed two, four, five or six times from June through september. Lint yields of plants adjacent to the millet and pigweed plots were reduced by an average of 112 lbs/acre (69%) and 162 lbs/acre (93%), respectively. All millet and pigweed plots, except respectively. All millet and pigweed plots, except those that had been mowed after July 27, had enough residue on February 10, 1983, to prevent wind erosion. A 27.5 inch-wide band of the native wind erosion. A 27.5 inch-wide band of the native grass Texas panicum produced enough residue in 1982 to keep soil losses in the adjacent 56 feet below 5 tons/acre if the erosive winds are perpendicular to the band of grass. Single rows of Ermelo lovegrass and Kleingrass Sel. 75 atop small, parallel terraces spaced 62 feet apart did not significantly affect lint yield of cotton grown between the terraces. A single row of Aztec Maximilian sunflower reduced yields 38%. The two grasses adequately protected the 62 foot interval from erosion by perpendicular winds. The less dense sunflower harrier would protect no more than a 40 foot barrier would protect no more than a 40 foot interval. (Murphy-IVI) W84-03063

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IRRIGATION DECISIONS SIMPLIFIED WITH ELECTRONICS AND SOIL WATER SENSORS Agricultural Research Service, Kimberly, ID. Snake River Conservation Research Center. For primary bibliographic entry see Field 2G. W84-03183

SIMULATING THE EFFECTS OF WEATHER VARIABLES AND SOIL WATER POTENTIAL ON A CORN CANOPY TEMPERATURE,

Agricultural Research Service, Phoenix, Water Conservation Lab.

Water Ossaria B. Choudhury. Agricultural Meteorology, Vol. 29, No. 3, p 169-182, 1983. 6 Fig, 29 Ref.

Descriptors: \*Soil water potential, \*Canopy, \*Plant water potentials, Evaporation, Water loss, Irrigation, Temperature effects, Soil properties, Corn, Plant growth, Leaves, Water potential, Water stress, Soil-water-plant relationships.

It has long been recognized that plant temperatures can be used as an indicator for soil water status. When the plant available soil water decreases, the canopy temperature increases. A soil-plant-atmosphere model based on the solution of Monteith's and van den Honert's equation for transpiration is used to study the dependence of corn canopy temperature on weather variables, soil water po-tential and rooting density. For unstressed canotential and rooting density. For unstressed canopies, air and dewpoint temperatures appear as the significant weather variables affecting the canopy temperature during a significant portion of clear-sky day periods. The present simulation gives a quasi-linear relationship between the canopy-air temperature difference and the air vapor pressure deficit. The relationship, however, is found to depend on the rooting density and hence on the soil strength. The canopy-air temperature difference values at lower soil water potentials are linearly related to the same values at field canocity. early related to the same values at field capacity, the coefficients (intercept and scope) of this rela-tionship being dependent on the soil water poten-tial through the crop water stress index. The variathan intogen the crop water stress index with the soil water potential is given for a silt loam soil. The stomatal resistance function is a pivoting relationship in a soil-plant-atmosphere model. (Baker-IVI) W84-03210

INCIDENTAL EFFECTS OF AGRICULTURAL WATER CONSERVATION,

California Univ., Davis. Dept. of Land, Air and Water Resources.

D. C. Davenport, H. J. Vaux, Jr., and R. M.

California Agriculture, Vol. 37, No. 3 and 4, p 28-31, March-April, 1983. 3 Fig, 1 Tab.

Descriptors: \*Water conservation, \*Agriculture, Irrigation practices, Farming, Cost analysis, Economic aspects, Management, Water quality, Water

Over 400 potential incidental effects of agricultural water conservation actions are identified and divided into 23 categories. Identification of an incidental ed into 25 caregories, Identification of an incidental effect does not always show the magnitude of its importance, which depends partly on local conditions and partly on the extent of the water conservation action. Energy related effects occur both on and off the farm, depending on the specific conservation action and source of water. In general, the most pertinent on-farm effects are those related to farm net returns including production input fac-tors, such as energy, fertilizer, labor, management, and other production costs and those related to production output, namely crop responses to water production output, namely crop responses to water quantity and quality, to pathogens, to pests and the risks associated with conservation actions that affect the yield of marketable produce. Most of the 23 categories of incidental effects identified have both private and external impacts. Methods of estimating both private and external technological costs and benefits are well developed both concep-tually and theoretically. Recognition of some inci-dental effects may give growers additional incen-tives to conserve water. (Baker-IVI)

IRRIGATION SCHEDULING UNDER SALINE

HIGH WATER TABLES, California Univ., Davis. Cooperative Extension. S. W. Kite, and B. R. Hanson. California Agriculture, Vol. 38, No. 1 and 2, p 12-14, January-February, 1983. 4 Fig, 1 Tab.

Descriptors: \*Soil salinity, \*Soil water, \*Salinity, Water table, Irrigation practices, Irrigation, Water supply, Leaves, Water potential, Water stress.

A technique has been developed for scheduling an irrigation program for a farm of 48 hectares in a saline high water table area. Maximum depth to saline high water table area. Maximum depth to the water table during the summer was about 4 feet. The electrical conductivity of the drainage water was about 4500 ppm, while that of the irrigation water was about 130 ppm. The soil type was mainly Armona clay for the top 10 inches. The rest of the soil profile was highly stratified with lenses of sand, silt or clay. Cotton was grown during the period of this project. An increase in

irrigation intervals resulted in greater soil moisture depletion. Soil moisture depletion was greater when the pressure chamber was used for irrigation scheduling. Normally, intervals between irrigations under saline conditions should be smaller than under same conditions should be smaller than those under nonsaline situations to minimize yield reductions. However, in this study the interval could be increased and it was suggested that soil moisture rather than soil salnity may have been the controlling factor for scheduling irrigations at that location. (Baker-IVI) W84-03222

COMPUTER SCHEDULES IRRIGATION.

Montana State Univ., Bozeman.
J. Bauder.
Crops and Soils Management, Vol. 35, No. 8, p 1517, June-July, 1983. 4 Fig.

Descriptors: \*Irrigation practices, \*Computers, Irrigation, Water supply, Rain gages, SCHEDULE,

Proper irrigation scheduling is somewhat like keeping track of the balance of a minimum balance checking account, while at the same time trying to decide how much should go into savings and how much should go into checking. A computer program has been developed that can help a person keep track of the balance of water available in an irrigation system, tell how fast the water is being taken out by the growing crop, give the anticipated date when the minimum amount of water will be left in the system and the amount that should be added to replenish this amount. At the beginning added to replenish this amount. At the beginning of the growing season the irrigator establishes a file for his particular field. This file contains information on the crop to be grown, its date of emergence, and the type of soil involved. As the season progresses, the irrigator adds information on rainfall and other weather conditions. The computer calculates the rate of growth of the crop and the amount of water it will have used, then tells how much water should be left in the soil and when more will be needed. (Baker-IVI)

ROOT DISTRIBUTION AND WATER USE EF-FICIENCY OF ALFALFA AS INFLUENCED BY DEPTH OF IRRIGATION, Mississippi State Univ., Mississippi State. Dept. of

Agronomy.
For primary bibliographic entry see Field 2I.
W84-03241

IRRIGATION REGIME EFFECTS ON SOME PHYSIOLOGICAL RESPONSES OF POTATO, Agricultural Research Organization (Israel). Gilat Regional Experiment Station. For primary bibliographic entry see Field 2I. W84-03244

CROP YIELD - IRRIGATION RELATION-SHIPS IN A GYPSIFEROUS-SODIC SOIL, Agricultural Research Organization, Bet-Dagan (Israel). Div. of Soil Physics.

D. Russo. Agronomy Journal, Vol. 75, May-June, p 427-434, 1983. 6 Fig, 4 Tab, 15 Ref.

Descriptors: \*Crop yield, \*Irrigation effects, \*Gypsiferous-sodic soil, Soil water suction, Salinity, Soil water potential, Bell pepper, Tomatoes.

Many desert soils in the Arava Valley of Israel contain appreciable amounts of stones, gypsum, and exchangeable Na, and very high salinity. Plant growth in such soils is dependent primarily on the possibility of leaching the soil prior to the growing season as well as on controlling the soil growing season as well as on controlling the soil water content and salinity within the root-zone during the growing season. Three different amounts of water (in terms of pan evaporation) at two different irrigation frequencies (daily irrigation and irrigation every 3 days) resulted in different soil water suction and salinity profiles, each of which can be characterized by a time average and the profiles each of our content of the conte the variance about this average. Average (over

#### WATER SUPPLY AUGMENTATION AND CONSERVATION—Field 3

#### Conservation In Agriculture—Group 3F

time) soil water potential (ave psi) increased as both the amount of irrigation water (QY) and the irrigation frequency (I) increased. For a given I, the (ave psi)-Q' relationships can be described by a hyperbolic function. In the gyapiferous-sodic soil the salinity of the soil solution was highly correlated with the exchangeable Na of the soil, which, in turn, was reduced with added irrigation water. Relative yields, Y, of the two crops were linearly dependent on the variance of the soil-water potential, independent of the irrigation regime. This implies that the yield-soil-water potential relationship can be described by a quadratic function. As opposed to the unique Y-(ave psi) relationships, the Y-Q' relationships depend on the irrigation frequency. For a given Q', yields of both crops obtained under daily irrigation were higher than the yields obtained under irrigation once in 3 days. Highest fruit yields were 126.1 Mg/ha of tomatoes and 62.7 Mg/ha of bell pepper; the respective amounts of irrigation water were 1,013 and 2,164 mm (109%) and 160% of the evaporation from a Class A pan). (Murphy-IVI)

LEAF AND CANOPY TEMPERATURES OF PEARL MILLET GENOTYPES UNDER IRRI-GATED AND NONIRRIGATED CONDITIONS, International Crops Research Inst. for the Semi-Arid Tropics, Patancheru (India). P. Singh, and E. T. Kanemasu. Agronomy Journal, Vol. 75, p 497-501, May-June, 1983. 5 Fig. 4 Tab, 19 Ref.

Descriptors: \*Irrigation effects, \*Leaf tempera-tures, \*Canopy temperatures, \*Pearl millet, Water stress, Plant water potential, Transpiration, Drought resistance.

Previous research reports that leaf and canopy temperatures correlate with the level of water stress in a plant. If genotypes of a given species differ in their response to water stress, then leaf and canopy temperatures could serve as indices of their drought resistance. To test this hypothesis, 10 pearl millet (Pennisetum americanum (L.) Leeke) resoutures differing in plant worthology. genotypes differing in plant morphology were grown on a Eudora silt loam soil (fine silty, mixed grown on a Eudora siit toam soit (tine sitty, mixed, mesic, Pachic Haplustoll) under both irrigated and nonirrigated conditions. Leaf temperature (TI), canopy temperature (Tc), canopy minus air temperature (Tc - Ta), leaf-water potential (psi sub i), leaf-diffusion resistance (LDR), water use (WU), I) the analysis of resistance (LDR), water use (WU), and crop yields were observed in both irrigated and nonirrigated treatments. Significant differences (P < 0.05) were in the grain yield, Tc, and Tc-Ta of genotypes, only in the irrigated treatment. Grain genotypes, only in the irrigated treatment. Grain yield was negatively and significantly correlated with average afternoon Tc(r=-0.81) and average afternoon Tc - Ta(r=-0.78). Grain yield ratio (nonirrigated grain yield/ ririgated grain yield) was positively and significantly correlated with average afternoon Tl(r=0.64), average afternoon Tc(r=0.64), and average afternoon Tc - Ta(r=0.75). In the nonirrigated treatment, however, correlations of grain yield and grain yield ratio with various stress indices were insignificant. Average afternoon Tc and Tc - Ta was significantly correlated with average afternoon LDR only in the irrigated treatment. Average afternoon Tc and Tc - Ta in a nonstressed environment with an infrared - Ta in a nonstressed environment with an infrared thermometer could effectively be used as a technique to screen millet genotypes for their grain yield and grain-yield stability (nonirrigated grain yield/irrigated grain yield). (Murphy-IVI) W84-03251

FERTILIZER APPLICATION AND IRRIGA-TION MANAGEMENT OF BROCCOLI PRO-DUCTION AND FERTILIZER USE EFFICIEN-

California Univ., Riverside. Dept. of Soil and Environmental Sciences

J. Letey, W. M. Jarrell, N. Valoras, and R.

Beverly.

Agronomy Journal, Vol. 75, p 502-507, May-June, 1983. 5 Fig, 4 Tab, 6 Ref. OWRT project B-203-CAL. WRC project UCAL-WRC-W-564. OWRT and USDI grant Public Law 88-379. California Water Resources Control Board contract 9-029-

Descriptors: \*Fertilization, \*Irrigation management, \*Broccoli, Irrigation efficiency, Nitrogen, Furrow Irrigation, Crop yield, Irrigation effects,

Fertilizer and irrigation must be managed for efficient resource use and preservation of environmental quality as well as maximum production. Two furrow irrigation experiments growing broccoli (Brassica oleracea) were conducted. The first consisted of three N rates (90, 180, and 270 kg/ha), two irrigation treatments (replenishment of water lost by evapotranspiration and evapotranspiration plus 30%), and two N application procedures (application to the soil and in the irrigation water) on a sandy loam soil (coarse-loamy mixed, thermic plus 30%), and two N application procedures (application to the soil and in the irrigation water) on a sandy loam soil (coarse-loamy, mixed, thermic Typic Xerofluvent). Plant growth increased with increasing N application. For a given N application, there was higher average production with the lesser amount of water application. The method of N application had very little effect on production under the lower irrigation treatment, but production was consistently higher for N application with water rather than to the soil when the higher water application treatment was used. The ratio of N in the plant to N applied decreased with increasing N application, and decreased with higher water application, decreased with higher water application water as compared to soil application. The second experiment consisted of two N rates (115 and 225 kg/ha) and two N application procedures (application to soil and in the irrigation water) on a loamy soil (fine-loamy mixed, thermic Calcic Haploxeroll). Yield and N uptake were significantly higher with 225 as compared to 115 kg/ha of N. Conventional preplant and side-dress N application to the soil resulted in significantly higher broccoil head yield than injecting N in the irrigation water. Leaching of N was not a factor under the experimental conditions. (Author's abstract) mental cone W84-03252 nditions. (Author's abstract)

EFFECT OF FOLICOTE ANTITRANSPIRANT APPLICATION ON FIELD GRAIN YIELD OF MOISTURE-STRESSED CORN,

New Mexico State Univ., Las Cruces. H. D. Fuehring, and M. D. Finkner. Agronomy Journal, Vol. 75, No. 4, p 579-582, July-August, 1983. 1 Fig, 2 Tab, 9 Ref.

Descriptors: \*Folicote antitranspirant, \*Crop Yield, \*Moisture stress, \*Corn, Antitranspirants, Environmental effects, Esypotranspiration, Tranpiration, Drought, Moisture retention, Soil moisture retention, Optimum development plans.

Drought is one of the most important factors limit-Drought is one of the most important factors limiting the production of field crop. It has been established that the proportion of stomatal resistance to total resistance is less for carbon dioxide diffusion into the leaf than for water diffusion out of the leaf. total resistance is less for caroon dioxine diffusion into the leaf than for water diffusion out of the leaf. Folicote, a hydrocarbon film-type antitranspirant, was foliarly applied on moisture-stressed field corn (Zea mays L.) grown on Pullman silty clay loam (fine, mixed, thermic Torrertic Paleustoll) soil. Single seasonal applications (foliar spray with ground rig just prior to tasseling) resulted in average yield increases of 11 and 17%. Fields where both the upper and lower leaf surfaces were sprayed required 1.93 L/ha for maximum yield responses, 42% less than required where spraying was from the top only. The response was curvilinear with definite yield depression when rates were too great, indicating the need to determine optimum application. It was concluded that antitranspirant application is a feasible method of increasing corn yield under the conditions of this study. (Murphyl.) yield under IVI) W84-03255

YIELD AND WATER USE EFFICIENCY OF GRAIN SORGHUM IN A LIMITED IRRIGA-TION-DRYLAND FARMING SYSTEM, Agricultural Research Service, Bushland, TX. Conservation and Production Lab. For primary bibliographic entry see Field 2I. W84-03258

RESPONSE OF DRY BEANS TO DAILY DEFI-CIT SPRINKLER IRRIGATION,

Agricultural Research Service, Prosser, WA. D. E. Miller, and D. W. Burke. Agronomy Journal, Vol. 75, p 775-778, September-October, 1983. 1 Fig, 3 Tab, 9 Ref

Descriptors: \*Beans, \*Sprinkler irrigation, \*Water deficit, Irrigation requirements, Water requirements, Soil moisture retention, Water stress, Soil

Dry beans (Phaseolus vulgaris L.) are an important irrigated crop in the Pacific Northwest, but no information is available as to their water requirements under high-frequency sprinkler irrigation. The present study evaluates the response of dry beans to variable amounts of water applied daily by sprinkler, as affected by soil water-holding camacity. Studies were conducted on a Warden learn by sprinkler, as affected by soil water-holding ca-pacity. Studies were conducted on a Warden loam (coarse-silty, mixed, mesic Xerollic Camborthids) near Prosser Wash and (goarse-sity) mixed, mesic Aeroine Camboriniss) near Prosser, Wash, and on a Quincy sand to loamy sand (mixed, mesic Xeric Torripsamments) near Paterson, Wash. Irrigated was uniformly by solid-set sprinklers until near the time of full canopy, when irrigation variables were initiated and continued until harvest. On the loam soil yields were not reduced when daily sprinkler irri-cation was rough less then estimated autoritories. gation was much less than estimated evapotranspiration (ET). No more than 10 to 15 cm of water auon (E.I). No more than 10 to 15 cm of water need be applied from full cover until harvest. On the sandy soil, yields increased with water applied up to the equivalent of nearly 100% estimated ET. On the sandy soil, with limited water holding capacity, it is not possible to reduce irrigation to much below estimated ET without loss in yield. (Murphy-IVI) W84-03262

EVAPOTRANSPIRATION AND YIELD ESTI-MATION OF SPRING WHEAT FROM CANOPY TEMPERATURE,

Arizona Univ., Tucson. Dept. of Soils, Water and Engineering. For primary bibliographic entry see Field 2D. W84-03264

RESPONSE OF SOYBEAN CULTIVARS TO IR-RIGATION OF A CLAY SOIL,

Agricultural Research Service, Stoneville, MS. L. G. Heatherly.

Agronomy Journal, Vol. 75, p 859-864, November-December, 1983. 2 Fig, 6 Tab, 29 Ref.

Descriptors: \*Soybeans, \*Irrigation effects, \*Clay soil, Soil texture, Soil water potential, Crop yield, Soil-water-plant relationships.

Numerous investigations have shown that soy-beans 'Glycine max (L.) Merr.' will give a signifi-cant yield response to irrigation, especially when the supplemental water is applied during reproduc-tive development. However, the majority of these results have been obtained with soils ranging in teacure from the least of search learn. Singe over testure from silt loam to sandy loam. Since soy-beans are frequently grown on finer-textured soils, we conducted field experiments in 1979 and 1980 on Sharkey clay (Vertic Haplaquept, very-fine, on Sharkey clay (Vertic Haplaquept, very-line, montmorillonitic, thermic), a soil representative of that occurring in about 3 750 000 ha of the alluvial plain of the Mississippi River. Variables included initiation of furrow irrigation at the prebloom (V), beginning of bloom (BL), beginning of pod set (PS), and beginning of pod fill (PF) stages, plus a nonirrigated (NI) treatment, and three cultivars representing Maturity Groups V (Bedford), VI (Tracy), and VII (Bragg). Data were collected for seed vield, mature plant height, lodging, xylem (Tracy), and VII (Bragg). Data were collected for seed yield, mature plant height, lodging, xylem pressure potential, leaf area, and seasonal soil moisture status. In the 'wet' year of 1979, yields from irrigated Bedford and Tracy were not significantly greater than the respective NI yields of 2754 and 3368 kg/ha. The PF treatment of Bragg produced a yield of 36.30 kg/ha, however, and this was significantly higher than the yields of all other treatments of Bragg, as well as all treatments of Bedford. In the dry year of 1980, all treatments of Bedford. In the dry year of 1980, all trigation treatments of all cultivars increased yields about the NI treatment, although the PF treatment yields were only about one-half of those from PB or BL treatments, which were nearly equal. Seed yield was highest from Bragg and lowest from Bedford

#### Group 3F-Conservation In Agriculture

in all cases. Lodging was not significantly affected by any irrigation treatment. Mature plant height was significantly increased only in the BL treatment of Bedford in 1980. Measurements of xylem pressure potential, leaf area, and soil water potential in 1980 indicated that the NI plots were severly stressed; thus, response to irrigation should have been expected. Irrigation of soybeans growing in a clay soil should be initiated at or near bloom in a dry year, and at any period of stress during reproductive development in a 'wet' year. (Murphy-IVI) W84-03268

IRRIGATION OF SOYBEAN GENOTYPES DURING REPRODUCTIVE ONTOGENY. I. AGRONOMIC RESPONSES,

Nebraska Univ.-Lincoln. Dept. of Agronomy For primary bibliographic entry see Field 21. W84-03279

ALFALFA RESPONSE TO SOIL WATER DEFI-CITS. I. GROWTH, FORAGE QUALITY, YIELD, WATER USE, AND WATER-USE EFFI-CIENCY, Minnesota Univ., St. Paul. Dept. of Agronomy and

Plant Genetics.
For primary bibliographic entry see Field 21.
W84-03281

NUMERICAL ANALYSIS OF SOIL WATER MOVEMENT UNDER CONDITIONS OF RAPID INTERMITTENCY OF WATER APPLI-

Banaras Hindu Univ., Varanasi (India). Dept. of Geophysics. For primary bibliographic entry see Field 2G. W84-03418

EFFECT OF SMALL IRRIGATION AMOUNTS

EFFELT OF SMALL IRRIGATION AMOUNTS ON THE YIELD OF WHEAT, Punjab Agricultural Univ., Ludhiana (India). Dept. of Soils. P. R. Gajri, and S. S. Prihar. Agricultural Water Management, Vol. 6, No. 1, p 31-41, 1983. 3 Fig. 6 Tab, 6 Ref.

Descriptors: \*Crop yield, \*Wheat, \*Supplemental irrigation, Dry farming, Soil texture, Runoff,

In dryland agriculture the amount of water accessi-In arylana agriculture the amount of water accessi-ble to crops depends upon the amount of stored water in the potential rooting zone and rainfall during the growing season. Where rainfall exceeds the water storage capacity of the soil or its intensi-ty exceeds the infiltration capacity of the soil, the surface runoff may be collected during part of the wear and stored for sweetnessed increasing. Eigld surface runnit may be collected during part of the year and stored for supplemental irrigation. Field experiments were conducted over a period of 4 years on loamy sand and 3 years on sandy loam to study the effects of pre-seeding, post-seeding and split application of limited amounts of water on split application of limited amounts of water on dry matter accumulation and grain yield of wheat. Early season water stress decreased the rate of dry matter accumulation. Grain yield responded signi-ficiantly to irrigation 30 days after seeding irre-spective of the amount of water, year and soil type. Yield with post-seeding irrigation averaged 3518 kg/ha against 2317 kg/ha for unirrigated control in loamy sand and 4440 kg/ha against 3391 kg/ha in sandy loam. The increase in yield was manifested by a significant increase in the number of effective by a significant increase in yield was manifested by a significant increase in the number of effective tillers per m row length, number of grains per ear and thousand grain weight. Under dryland condi-tions wheat yields can be increased and stabilized by a small irrigation of stored water. This tions wheat years can be interested water. This irriga-tion is more crucial in coarse textured than in fine textured soils. For maximum benefit the stored water must not be applied until a few weeks after seeding in coarse textures soils. On finer textured soils the entire available water may be applied at the time of seeding. (Moore-IVI) W84-03434

CROP WATER REQUIREMENTS FOR RAINFED AND IRRIGATED GRAIN CORN IN

CHINA, California Univ., Los Angeles. Dept. of Geogra-

For primary bibliographic entry see Field 2D. W84-03435

AN ELECTRICAL ANALOGUE TO DESIGN SUBIRRIGATION SYSTEMS.

Institut voor Culturtechniek en Waterhuishoud-ing, Wageningen (Netherlands). F. Homma. Agricultural Water Management, Vol. 6, No. 4, p 321-333, 1983. 10 Fig, 1 Tab, 8 Ref.

Descriptors: \*Subsurface irrigation, Irrigation, Water supply, Netherlands, Water loss, Seepage, Groundwater flow, Water table, Model studies,

In humid areas such as northwestern Europe an excess of water occurs during winter. In the Netherlands, where drainage systems are usually well developed, damage to crops because of waterlogging of the soil rarely occurs, but during summer a water shortage may occur, caused by high evaportage transmistioners. tanspiration rates. In order to overcome possible damage from a water shortage in summer, the water level in the ditch and canal system in several water level in the their and canal system in several areas is kept high by letting water in. Filling the drainage system with water causes an inflow into the soil, preventing a groundwater table drop, so the crops are fed by groundwater throughout the growing season. Sub growing season. Subsurface irrigation is used in the northeastern part of the Netherlands to prevent drought damage to crops on reclaimed peat soils. Even so, high water losses due to deep seepage often prevent the building up of sufficiently high groundwater tables. Field data from a subsurface irrigation experimental field are presented to con-struct resistor, network models to simulate the irrigation experimental near are presented to con-struct resistor network models to simulate the groundwater flow in the field and its surroundings. The model shows very good agreement with field data. Models were also used to simulate other conditions in order to detect the influence of ditch water levels and the effect of irrigation applied over a larger area. (Baker-IVI) W84-03443

SOIL MANAGEMENT FOR SEMIARID RE-GIONS,

Minnesota Univ., St. Paul. Dept. of Soil Science. W. E. Larson, J. B. Swan, and M. J. Shaffer. Agricultural Water Management, Vol. 7, No. 1-3, p 89-114, 1983. 16 Fig. 1 Tab, 86 Ref.

Descriptors: \*Semiarid lands, \*Soil management, Water storage, Water use, Climate, Computer models, Simulation, Soil properties, Crop yield, Residue management, Tillage, Fallowing.

Water related climatic factors and soil physical and chemical properties exert a dominant effect on crop production in semiarid regions. Soil manage-ment practices which beneficially affect crop production by increasing water storage or through more efficient water use have been intensively studied at a number of locations with their associ-ated soil conditions and under the climatic condi-tions encountered. The practical benefits of such research have been extensive. The application of field research to specific sites is restricted by the extreme variations in climatic conditions, by the large differences in soil physical and chemical properties, and by the variation in management practices which occur in the region. Because of these soil and climatic differences, the probability levels of expected responses to management practices generally have not been determined. Part of the difficulty has been due to the inability to precievly define and numerically describe the soil and clied define and numerically describe the soil and climatic characteristics involved for sites and years other than those in which the research was conducted. Computer-based simulation techniques permit the development of long- and short-term permit the development of long- and short-term site specific soil management recommendations with expected results expressed on a probability basis. The research results from specific geograph-ic locations measured under a specific set of climat-ic conditions can thus be generalized to a much wider range of soils and expressed on a probability basis using long-term climatic records. Examples are given where crop yield frequencies are com-puted as a function of long-term climatic conditions involving various management practices.

These results illustrate the impacts of a range of residue management, deep tillage, and fallowing residue management, deep linage, and rainoving practices on crop production in the semiarid environment. The modeling techniques presented can be used with a range of models and potential management practices. (Author's abstract) W84-03450

PRINCIPLES OF WATER MANAGEMENT UNDER DROUGHT CONDITIONS,

Arizona Univ., Tucson. Dept. of Soils, Water and Engineering. W. R. Gardner, and H. R. Gardner.

Agricultural Water Management, Vol. 7, No. 1-3, p 143-155, 1983. 8 Fig, 8 Ref.

Descriptors: \*Water management, \*Drought, \*Dry farming, Crop yield, Summer fallow, Water harvesting, Surface water management.

In rain-fed agriculture the options for water man-agement are much more limited than for irrigated agriculture and the management tools available to the farmer are few. The major variable at his disposal is the selection of the crop to be grown.

The economic return per unit of water is the major factor to be considered. This usually implies the maximum possible ratios of grain or other harvested plant part to total dry matter. When the rainfall is just below amount needed for maximum dry matter production, this maximum can be achieved matter production, this maximum can be achieved through appropriate manipulation of the plant population. The optimum population depends both upon the characteristics of the plant and the amount and distribution of the precipitation. When the amount of precipitation is significantly less than about 25% of the optimum, then other management approaches are conjusted. ment approaches are required. A widespread solution to this problem has been summer-fallowing. However, in certain circumstances some variation on surface water management or water harvesting may be more advantageous. Criteria for decision making for optimum production under dry-land conditions are given. (Author's abstract) W84-03451

IRRIGATION IN THE GREAT PLAINS.

Kansas State Univ., Manhattan. Dept. of Agrono-

T. Kanemasu, J. L. Steiner, A. W. Biere, F. D. Worman, and J. F. Stone.

Agricultural Water Management, Vol. 7, No. 1-3, p 157-178, 1983. 4 Fig, 3 Tab, 102 Ref.

Descriptors: \*Irrigation scheduling, \*Great Plains, Soil water, Root zone, Evaporation, Transpiration, Hydrologic budget, Water stress, Economic as-

Irrigation scheduling answers the question of when to irrigate and how much. The techniques used for scheduling include the monitoring of soil moisture, physiological indicators and water balance models. The areas of major concern are: a soil moisture The areas of major concern are: a son monsture sensor which is inexpensive, rapid and accurate; a means of assessing the upper and lower limits of soil water content in the changing root zone; development of a rapid technique for estimating leaf area; and a means of measuring canopy transpiration. tion. A major research thrust than can be identified is the separation of evaporation from the soil surface and transpiration by the canopy. As one manipulates the canopy geometry to assess the cultural practices and irrigation systems, the need to clearly identify the contribution of evaporation and transpiration becomes increasingly important. The objective for irrigation for the farmer is to maximize his net returns. There are three components of an economic model for determining that decision: a water balance; a growth response function; and an economic optimization function. A few of the problem areas in such a scheme are: adaptation by the plant to water stress; dynamics of the root system; interaction between fertility and water; and sk analysis. (Author's abstract)

## Groundwater Management—Group 4B

#### 4. WATER QUANTITY MANAGEMENT AND CONTROL

#### 4A. Control Of Water On The Surface

OPERATIONAL FLOOD ROUTING FOR HYDROELECTRIC PLANTS,

National Technical Univ., Athens (Greece). Dept. of Civil Engineering. M. Mimikou.

International Water Power and Dam Construction, Vol. 35, No. 9, p 24-27, September, 1983. 2 Fig, 2 Tab. 8 Ref

Descriptors: \*Flood control, \*Design criteria, \*Powerplants, Construction, Model studies, Flood routing, Stochastic process, Hydraulic models, Greece.

A stochastic model is presented for transferring flood streamflows with lateral inflows. The model overcomes former difficulties and has been used successfully in the design and operation of hydroelectric plants. Calibration of hydraulic flood routing models is based on field information which is limited and extremely variable in space and time for most large natural streams. Thus, serious difficulties and inaccuracies are caused when hydraulic flood routing is used in such cases. The developed operational flood routing stochastic model can be calibrated with data from a very short period of time and successfully overcomes the hydraulic flood routing application difficulties. There are some limitations on the use of the model, such as when the flow velocity is needed, or there is no outflow information. The successful application of the model to several natural streams in Greece has shown its validity for the design and operation of hydroelectric plants. (Baker-IVI) W84-02993

#### GRAVITY WASTEWATER COLLECTION SYS-TEMS OPTIMIZATION.

Indian Inst. of Tech., Bombay. For primary bibliographic entry see Field 5B. W84-03092

## SHORT-TERM CLIMATE PREDICTIONS FOR

WATER MANAGEMENT, California State Dept. of Water Resources, Dia-C. A. McCullough.

Bulletin of the American Meteorological Society, Vol. 64, No. 11, p 1273-1275, November, 1983.

Descriptors: \*Short-term planning, \*Climate, \*Prediction, \*Water management, Management planning, Forecasting, Water supply, Flood control,

Short-term climate predictions (two weeks to two years) have many applications to operation of water supply and flood control facilities. They influence use of water for irrigation, hydroelectric power production, flood control operation, recreational use of reservoirs, and numerous related water operations. The climate predictions now available have some limited usefulness. Those given an average skill factor of 65% can influence water management decisions. Short-term climatic predictions will be particulatly useful to operators of large water projects who must often base decisions for reservoir releases on expected weather conditions over the next 15-30 days. (Murphy-IVI) W84-03156

## EVAPORATION FROM SCREENED CLASS A PANS IN A SEMI-ARID CLIMATE,

Agricultural Research Service, Fresno, CA. Water Management Research Lab. For primary bibliographic entry see Field 2D. W84-03207

INTERPOLATION OF SHORT DURATION RAINFALL FROM 24-HOUR RAINFALL IN LOWER GODAVARI BASIN, Meteorological Office, New Delhi (India). For primary bibliographic entry see Field 2B. W84-03307

THE KERNEL FUNCTION FOR WATERSHED RUNOFF MODELING, Wuhan Inst. of Hydraulic and Electric Power En-gineering (China). For primary bibliographic entry see Field 2E. W84-03335

## URBAN DESIGN-STORM SENSITIVITY AND

DRBAN DESIGN-STORM SENSITIVITY AND RELLABILITY, Prickett (Thomas A.) and Associates, Urbana, IL. M. L. Voorhees, and H. G. Wenzel, Jr. Journal of Hydrology, Vol. 68, p 39-60, 1984. 12 Fig. 5 Tab, 25 Ref. OWRT project A-095-ILL.

Descriptors: \*Urban runoff, \*Design storms, \*Sensitivity, \*Reliability, Computer models, Digital computers, Soil water, Model studies.

Computers, Soil water, Model studies.

Urban-runoff design-storm selection has in the past been arbitrary at times, leading to inadequate and unreliable capacity design of urban-runoff structures. By utilizing a continuous urban-runoff digital computer model, the frequency response of selected urban basins to a selected historical point-rainfall record is generated. The model evaluates the sensitivity of the frequency response to design-storm parameters and antecedent soil moisture. This frequency response is used as a criterion for the selection of design storms. Sensitivity was exhibited by all the design-storm elements, confirming the feasibility of design storm reliability analysis Expectation analysis is applied to obtain estimates of reliable design storms. Expectation analysis yields reliable design storms. Expectation analysis to a two-parameter design-storm model is one practical recommendation. (Murphy-IVI)
W84-03336

#### ESTIMATING RESIDENTIAL FLOOD CONTROL BENEFITS USING IMPLICIT PRICE EQUATIONS.

EQUATIONS, Union Pacific Railroad, Omaha, NE. E. Thompson, and H. H. Stoevener. Water Resources Bulletin, Vol. 19, No. 6, p 889-895, December, 1983. 2 Tab, 10 Ref.

Descriptors: \*Flood control, \*Economic factors, Model studies, Mathematical equations, Land appraisals.

Estimating the value of changes in the quality of the environment has proven to be a difficult task. Public good characteristics typical of environmen-tal attributes, such as the quality of the air, pre-clude the development of markets for these at-tributes. Without market transactions the economic clude the development of markets for these attributes. Without market transactions the economic value of environmental amenities cannot be observed directly. The application of implicit price equations to estimate the benefits from changes in the level of price determining characteristics such as air quality are numerous. However, empirical studies of flood control induced benefits are rare. An implicit price model relating residential lot value to price determining characteristics of land can measure the benefits of a structural flood control project. Special attention is given to the selection of relevant price determining characteristics of residential lots. An implicit price equation is estimated for both the with and without project conditions. Flood damages are quantified through the use of a dummy variable indicating a flood plain location. The analysis shows that annual flood damages were reduced by \$15,275. Regression analysis results indicate that residential lots exposed to the flood hazards of Sutherlin Creek are valued less than lots not exposed to the threat of flooding. The value differential reflects the discounted value of expected damages associated with an unprotected flood plain location. Alternatively, it reflects the benefits derived from flood control. (Murphy-IVI) (Murphy-IVI) W84-03392

# FLOOD ROUTING THROUGH A FLAT, COM-PLEX FLOODPLAIN USING A ONE-DIMEN-SIONAL UNSTEADY FLOW COMPUTER PRO-

GRAM, Hydrologic Engineering Center, Davis, CA. For primary bibliographic entry see Field 8B. W84-03395

### ENVIRONMENTAL ASPECTS OF CLEARING

AND SNAGGING,
Army Engineer Waterways Experiment Station,
Vicksburg, MS. Environmental Lab.
For primary bibliographic entry see Field 6G.
W84-03473

#### 4B. Groundwater Management

## GROUNDWATER MONITORING WELL

Hart (Fred C.) Associates, Inc., Newark, NJ. P. Franconeri. Pollution Engineering, Vol. 15, No. 8, p 24-26, August, 1983. 2 Fig.

Descriptors: \*Monitoring, \*Groundwater pollu-tion, Water quality control, Groundwater protec-tion, Water supply, Drinking water, Wells, Moni-toring wells.

Installation of monitoring wells at a hazardous waste site is an important element in a groundwater investigation. A step-by-step description is presented for engineers involved with hazardous waste management. A flow chart is provided of the steps typically required to install groundwater monitoring wells at such a site. Information is provided on the following aspects of the job: well logs, site visit, well design, specifications, safety requirements, bidding, contract award, permits and clearances, test borings, well installation and well location. (Baker-IVI) W84-03048

# SUBSURFACE INJECTION OF TREATED SEWAGE INTO A SALINE-WATER AQUIFER AT ST. PETERSBURG, FLORIDA - AQUIFER PRESSURE BUILDUP,

Geological Survey, Tampa, FL.
For primary bibliographic entry see Field 5D.
W84-03078

MICROCOMPUTER MODEL OF ARTIFICIAL RECHARGE USING GLOVER'S SOLUTION, D. Molden, D. K. Sunada, and J. W. Warner. Ground Water, Vol. 22, No. 1, p 73-79, January-February, 1984. 12 Fig. 9 Ref. Office of Water Resources Technology and Colorado State University Experiment Station project 1-51101.

Descriptors: \*Computer models, \*Artificial re-charge, Discharge measurement, Groundwater re-charge, Computer programs, Groundwater charge,

An interactive program written for an APPLE II 48 microcomputer provides an analytical solution for recharge from a rectangular basin. R. E. Grover published in 1960 through the USDA Ag-ricultural Research Service in Ft. Collins, Coloraricultural Research Service in Ft. Collins, Colorado, a paper offering a solution to mathematical derivations in groundwater recharge. This microcomputer model written in BASIC adapts Glover's solution to computerized application. The model is capable of graphically displaying the rise and decline of the recharge mound for either an infinite homogeneous medium or for a stream aquifer system. Using this program a large number of recharge strategies can be graphically worked out by hydrologists, including soil parameters and characteristics, plus unusual boundary conditions. (Wheatley-IVI)

#### GROUND-WATER MOUNDING BENEATH A LARGE LEACHING BED,

Ontario Hydro, Toronto. H. T. Chan, and J. F. Sykes.

#### Group 4B-Groundwater Management

Ground Water, Vol. 22, No. 1, P 86-93, January-February, 1984. 9 Fig. 17 Ref.

Descriptors: \*Groundwater mounding, \*Groundwater recharge, \*Water level fluctuations, \*Artificial recharge, Infiltration, Ontario, Norwood, Leaching, Mathematical models, Hydraulic loading.

An 84 m (276 ft) by 64 m (205 ft) experimental leaching bed was constructed to receive the secondary effluent from the Norwood, Ontario sewage treatment plant. The distribution system consisted of 100 mm diameter perforated pipes laid 2.1 m apart in 0.45 m wide trenches. The main soil layer at the test site was sandy silt. Ground-water levels at the site were measured approximately weekly at 36 piezometers for a period of about 2.17 years. An initial hydraulic loading of 122,700 1/ day caused surface ponding. A reduced loading of 40,900 1/day was then used for most of the study period. Ground-water level fluctuations beneath and adjacent to the leaching bed were attributed to seasonally varying infiltration and hydraulic loading. The experimental data were simulated using at ransient two-dimensional, phreatic integrated depth finite-element model and an analytic solution for ground-water mounding. Results from the study indicated that seasonal infiltration was a controlling factor in determining leaching bed design loads. Both mathematical models were found adequate for design. (Author's abstract)

PRELIMINARY STUDY OF THE DIVERSION OF 283 CU M/S (10,000 CFS) FROM LAKE SU-PERIOR TO THE MISSOURI RIVER BASIN, Michigan Univ., Ann Arbor. Dept. of Civil Engimenting.

J. W. Bulkley, S. J. Wright, and D. Wright. Journal of Hydrology, Vol. 68, p 461-472, 1984. 2 Fig. 5 Tab, 13 Ref.

Descriptors: \*Baseline studies, \*Diversion. \*Lake Superior, \*Missouri River Basin, Groundwater depletion, Groundwater recharge, Diversion channels, Diversion structures, Economic aspects, Recharge Basins, Ogallala aquifer, Static head.

Trans-basin diversion is an established practice in this country. The High Plains Study authorized by the U.S. Congress in 1976 examined large-scale intra-basin diversion to replenish the depleted groundwater resources of the Ogallala aquifer. A portion of this intra-basin diversion could come from the Missouri River basin. This is the preliminary engineering associated with a large-scale diversion of Lake Superior water out of the Great Lakes and into the Missouri River basin in order to replace intra-basin water diverted for recharge of the Ogallala aquifer. The magnitude of the diversion is 283 cu m/s (10,000 cfs). The first cost of the conveyance structure is estimated at US \$19.6 billion. The total length is estimated at 984 km and the total static lift including friction losses, static head, and pumping plants will be required to lift the water from Lake Superior and transport it to the Missouri Basin. As estimated energy requirement to move this water is equivalent to the annual energy production from seven 1000-Mw plants. Initial costs of these power plants is estimated at \$7 billion. (Murphy-IVI)

A LAND-USE POLICY BASED ON WATER SUPPLY,

Wilson (Lee) and Associates, Inc., Santa Fe, NM. For primary bibliographic entry see Field 6F. W84-03398

ENGINEERING ECONOMIC ANALYSES OF ARTIFICIAL RECHARGE IN THE COLUMBIA BASIN PROJECT, WASHINGTON,

BASIN PROJECT, WASHINGTON, Geological Survey, Lakewood, CO. M. R. Karlinger, and A. J. Hansen, Jr. Water Resources Bulletin, Vol. 19, No. 6, p 967-975, December, 1983. 9 Fig, 4 Tab, 5 Ref, 1 Append.

Descriptors: \*Artificial recharge, \*Columbia Basin Project, \*Washington, \*Groundwater irrigation, Surface irrigation, Energy costs, Cost analysis, Water importing, Water conveyance, Water distribution.

Appraisal-level, engineering economic analyses for two types of irrigation systems are compared: a surface-water irrigation system, and a ground-water recharge irrigation system. The study area is in the southern part of the Columbia Basin Project, where development of irrigable land is in the planning stage. The proposed plan is to import water from Franklin D. Roosevelt Lake in northeastern Washington through an extension of the East Low Canal and to apportion the water to farm units using a lateral distribution system. An artificial recharge irrigation alternative would divert water from the lateral system and deliver it to recharge facilities, using the same supply facility and canal extension. The aquifer would then be used to convey water to individual agricultural units for irrigation pumping. An artificial recharge irrigation system is an economically viable alternative to surface-distributed irrigation in a conjunctive irrigation plan if electric power rates remain sufficiently low. As electric rates increase, this viability generally decreases until it becomes completely unattractive at rates of about \$0.012/kwh. (Moore-IVI)

#### 4C. Effects On Water Of Man's Non-Water Activities

EFFECTS OF SURFACE MINING ON AQUATIC RESOURCES IN NORTH AMERICA, For primary bibliographic entry see Field 5B. W84-0319.

#### 4D. Watershed Protection

CROSS-COMPLIANCE TO ENFORCE SOIL AND WATER CONSERVATION, Wisconsin Univ.-Madison. Dept. of Urban and Re-

Wisconsin Univ.-Madison. Dept. of Urban and Regional Planning.

J. I. K. Wildmann.

Journal of Soil and Water Conservation, Vol. 38, No. 2, p 75-78, March-April, 1983. 1 Fig, 2 Tab, 20 Ref.

Descriptors: \*Erosion control, \*Cross-compliance, Planning, Conservation, Soil conservation, Water conservation, Soil and Water Resources Conservation Act, Legislation, Government finance.

Among the strategies proposed in the Soil and Water Resources Conservation Act process was cross-compliance. This strategy would require that farmers carry out a program of soil and water conservation acceptable to the US Department of Agriculture in order to participate in USDA's commodity, loan, and insurance programs. Such a policy raises several conservation policy questions. The advantages of cross-compliance include the avoidance of practices that cause erosion and sedimentation, thus yielding increased soil conservation benefits for all. New cropping and tillage combinations include minimum tillage, residue management, lengthening and changing crop rotations, and changing the timing of cultivation. Alternative land treatment practices include contouring, stripcropping, and terracing. Some practical problems inherent in the cross-compliance scheme are discussed. (Baker-IVI)

WHAT IS CONSERVATION TILLAGE,

Purdue Univ., Lafayette, IN. Dept. of Agronomy. J. V. Mannering, and C. R. Fenster. Journal of Soil and Water Conservation, Vol. 38, No. 3, p 140-143, May-June, 1983. 1 Fig. 5 Ref.

Descriptors: \*Erosion control, \*Soil conservation, Conservation tillage, Farming, Farm practices, Farm management, Tillage, Planning.

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The suggestion is made that conservation tillage be used as an umbrella term, and that all tillage practices that conserve soil and water be listed under that term. Forms of row crop tillage include narrow strip tillage, not-tillage, strip rotary tillage, ridge planting, till-planting, full-width no-plow tillage, fall or spring chiseling, fall-spring disking, full-width plow tillage and wheel-tack planting. Forms of small grain tillage discussed include stirring and mixing machine tilling and stubble-mulch farming. People discussing conservation tillage are really talking about a system of farming. Equipment needs must be approached as a system based on soil and climatological conditions. The system must adequately control soil erosion, conserve moisture, and accommodate the crops grown. Weed, disease and insect control chemicals must be better understood. The fertility needs of crops grown with conservation tillage systems must be met efficiently. How conservation tillage affects labor and energy demands must be learned. (Baker-IVI)

CONSERVATION TILLAGE FOR EROSION CONTROL.

National Soil Erosion Lab., West Lafayette, IN. W. C. Moldenhauer, G. W. Langdale, W. Frye, D. K. McCool, and R. I. Papendick.
Journal of Soil and Water Conservation, Vol. 38, No. 3, p 144-151, May-June, 1983. 4 Fig, 6 Tab, 25

Descriptors: \*Erosion control, \*Soil conservation, Tillage, Farm management, Agriculture, Soil erosion, United States, Vegetation, Vegetation effects.

A region-by-region assessment is given of conservation tillage's effectiveness in controlling soil loss. In 1981 conservation tillage was used on one-third of the harvested cropland in the Corn Belt. The percentage of cropland in no-till was near the national figure of 2.5%. In the Corn Belt reduction of erosion seems to be a matter of leaving sufficient residue on the surface. In the Southeast it is important to break up the pan that forms each year in soil that is moldboard-plowed or even disked. Chiselling in the row breaks up the pan and allows moisture to get into the root zone, reducing runoff and erosion. In the Great Plains wind erosion is generally more serious than water erosion. Living or dead vegetation, again, is more effective than surface roughness in reducing erosion. Vegetation lifts the wind and also increases the percentage of nonerodible aggregates in conservation tillage practices. In the Pacific Northwest, growing vegetation is established. No-tillage seeding of wheat has proved successful in reducing erosion, though under deep frozen soil conditions it may not reduce runoff. Surface roughness and surface residue prevent a continuous frost layer under shallow frozen soil conditions and help to reduce runoff. (Baker-IVI)

WATER QUALITY CONSEQUENCES OF CONSERVATION TILLAGE,

J. L. Baker, and J. M. Laflen. Journal of Soil and Water Conservation, Vol. 38, No. 3, p 186-193, May-June, 1983. 4 Tab, 53 Ref.

Descriptors: \*Water quality, \*Water pollution sources, \*Conservation tillage, Tillage, Erosion control, Soil conservation, Farm management, Vegetation, Agriculture, Runoff, Agricultural chemicals, Pesticides, Fertilizers.

Conservation tillage, which leaves some of all of the residue from the previous crop on the soil surface, effectively protects the soil against erosion. However, in order to maintain crop residues on the soil surface the use of fertilizers and pesticides is somewhat limited, affecting chemical concentrations and losses in surface water and sediment. Crop residue on the soil surface reduces runoff from all storms and eliminates runoff from most small storms. The slight to moderate reduction in runoff expected with conservation tillage

#### WATER QUALITY MANAGEMENT AND PROTECTION—Field 5

#### Identification Of Pollutants-Group 5A

systems will not alone have large impacts on the quality of receiving waters relative to chemicals lost in surface runoff. Of more importance in improving water quality is the soil conservation potential of conservation tillage and its impact on chemical losses with sediment. What impact con-servation tillage has on chemical concentrations in servation usage has on chemical concentrations in runoff relates to the placement of agricultural chemicals during application and to the impact of conservation tillage on infiltration and runoff, particularly during the first storm after application, when most soluble losses occur. (Baker-IVI) W84-03060

IRRIGATION + DRYLAND FARMING + LIMITED TILLAGE: A PROFITABLE COMBINATION, Agricultural Research Service, Bushland, TX. Conservation and Production Lab.
A. F. Wiese, and P. W. Unger.
Journal of Soil and Water Conservation, Vol. 38, No. 3, p 233-236, May-June, 1983. 3 Fig, 4 Tab, 15 Ref.

Descriptors: \*Erosion control, \*Irrigation practices, \*Crop yield, Economic aspects, Agriculture, Irrigation, Water conservation, Soil conservation.

Current research has produced new insights into methods of combining limited irrigation, dryland farming, and limited tillage into profitable conservation farming systems for the 1980s. Attempts have been made to exploit the advantage of mulch on the soil surface in the Southern High Plains. Because soil water storage and crop yields increased with an irrigated straw mulch and because not enough mulch could be grown under dryland farming conditions, it seemed logical that by alternating irrigated and dryland cropping, dryland crops could be forced to yield more. Several advantages have been noted through several studies performed in the Southern High Plains. Because of increased soil water storage, dryland crop yields not only increased, but crop failures were less frequent. Increased yields and lower production costs increased the profits. Finally, high levels of crop residue on the soil surface greatly reduced the Current research has produced new insights into crop residue on the soil surface greatly reduced the threat of soil erosion by wind and water. (Baker-W84-03061

SOIL AND NUTRIENT RUNOFF LOSSES WITH IN-ROW, CHISEL-PLANTED SOY-

Agricultural Research Service, Watkinsville, GA. For primary bibliographic entry see Field 2J. W84-03062

RESIDUE MANAGEMENT AND CULTURAL PRACTICES FOR A SEMIARID REGION, Agricultural Research Service, Big Spring, For primary bibliographic entry see Field 3F. W84-03063

LONG-TERM ANNUAL RUNOFF AND SOIL LOSS FROM CONVENTIONAL AND CONSER-VATION TILLAGE OF CORN,

Agricultural Research Service, Columbia, MO. R. E. Burwell, and L. A. Kramer.

Journal of Soil and Water Conservation, Vol. 38, No. 3, p 315-319, May-June, 1983. 5 Fig, 1 Tab, 14

Descriptors: \*Soil conservation, \*Tillage, Runoff, Erosion control, Erosion, Missouri, Claypan, Soil loss, Corn, Farm management.

Conservationists recognize that maximum average Conservationsis recognize that maximum average soil loss rates that would permit maintenance of crop production need to be specified for conserva-tion system design. A central Missouri claypan soil had runoff and soil loss for conservation tillage 85 had runoff and soil loss for conservation tillage 85 and 42%, respectively, of that for conventional tillage. Annual soil loss was 54 and 63% of the average annual predicted soil loss for conventional and conservation tillage, respectively. Runoff for corn after corn using conservation tillage. Soil loss for corn after corn using conservation tillage. Soil loss for corn after corn using conservation tillage soil sos for corn after corn using conservation tillage.

less than that for conventional tillage. Average annual soil losses for both tillage treatments on a 27.4 m long slope were less than the T-value of 6.7 metric tons per hectare per year currently used in conservation planning. (Murphy-IVI)

RESIDUE MANAGEMENT TO REDUCE FURROW EROSION, Agricultural Research Service, Prosser, WA. Irri-MANAGEMENT TO REDUCE

gated Agriculture Research and Extension Center. D. E. Miller, and J. S. Aarstad. Journal of Soil and Water Conservation, Vol. 38, No. 4, p 366-370, July-August, 1983. 1 Fig, 7 Tab, 15 Ref.

Descriptors: \*Erosion control, \*Irrigation practices, Soil conservation, Water conservation, Tillage, Herbicides, Turbidity, Runoff, Erosion.

Proper use of crop residue is the most powerful tool available for reducing runoff, erosion and sedimentation. Controlled streams applied to irrigation furrows containing various amounts of plant residue controls erosion and reduces turbidity of runoff water. Nonuniformity of infiltration rates pose a problem along a furrow. The use of surge furrow inflow in combination with furrow residue to control erosion may improve infiltration uniteration. to control erosion may improve infiltration uni-formity. Relatively small amounts of residue effec-tively reduce erosion. Thus, limited tillage to prepare a seedbed and incorporate herbicides is possible, while leaving adequate residue in the furrows to control erosion. (Murphy-IVI) W84-03065

SOIL CONSERVATION STRATEGIES IN THE THIRD WORLD, National Coll. of Agricultural Engineering, Silsoe

(England). N. W. Hudson.

Journal of Soil and Water Conservation, Vol. 38, No. 6, p 446-450, November/December, 1983. 1 Fig, 1 Tab, 14 Ref.

\*Soil conservation, \*Developing countries, Water supply, Water conservation, Agriculture, Farming, Conservation, Soil erosion,

Third World countries are facing tough problems in the area of soil conservation that require different solutions than do problems in developed counries. An approximate picture of the erosivity of rainfall can be gathered from data sources around the world. But the data is far from complete in the region of the Third World countries. It is even region of the Third World countries. It is even more difficult to produce a worldwide comparative study of erodibility because of the lack of a universally applicable index of erodibility of the soil. The risk of high soil loss from steep land is compounded by inappropriate use of the land. Non-technical problems encountered in the developing nations include political problems, reserved land, legislation, social features, fragmentation, a social significance attached to cattle, and the reluctage to move (Palext IVI). tance to move. (Baker-IVI) W84-03068

RUNOFF CURVE NUMBERS FOR CONSER-VATION TILLAGE,

Agricultural Research Service, Beltsville, MD.

Agricultural Research Service, Beltsville, MD. Hydrology Lab. W. J. Rawls, and H. H. Richardson. Journal of Soil and Water Conservation, Vol. 38, No. 6, p 494-496, November/December, 1983. 1 Fig, 1 Tab, 19 Ref.

Descriptors: \*Soil conservation, \*Erosion control, Conservation tillage, Tillage, Conservation, Water conservation, Erosion, Runoff velocity, Runoff.

Conservation tillage effects on runoff vary. A new set of Soil Conservation Service runoff curve num-bers reflect these effects, based on residue cover. pers retlect these effects, based on residue cover. The relative effectiveness of conservation tillage practices in controlling runoff depends on how much runoff velocity is reduced, how much sur-face storage is increased, how much conductivity and moisture storage is increased, and how much

raindrop impact is reduced. The SCS procedure for predicting runoff uses total-event rainfall. The amount of residue left on the soil surface or the percentage of the soil surface covered by residue indicates the effectiveness of conservation tillage practices in reducing runoff. Conservation tillage practices in reducing runoff. Conservation tillage causes a decline of 1 to 4 runoff curve numbers, translating into a reduction in runoff from 9 to 16% associated with fallow land in good hydrojecic conditions. The 9% reduction is associated with small grain, contoured and terraced with a good hydrologic condition. (Baker-IVI)

FIELD VERIFICATION OF RUNOFF CURVE NUMBERS FOR FALLOW ROTATION Kansas State Univ., Manhattan. Dept. of Agricul-For primary bibliographic entry see Field 2E. W84-03070

CONTROLLING AGRICULTURAL SOIL LOSS IN ARKANSAS' NORTH LAKE CHICOT WA-TERSHED: AN ANALYSIS OF BENEFITS, Arkansas Univ., Fayetteville. Dept. of Agricultural Economics and Rural Sociology. For primary bibliographic entry see Field 6B. W84-03071

EVALUATING RIPRAPPING AND OTHER STREAMBANK STABILIZATION TECH-

California Univ., Berkeley. Dept. of Forestry and

California Univ., Belacity. Exp. of Young and Resources Management.
J. R. McBride, and J. Strahan.
California Agriculture, Vol. 37, No. 5 and 6, May-June, 1983. 8 Fig.

Descriptors: \*Bank stabilization, \*Erosion control, Streams, Stream stabilization, Dry Creek, California, Sonoma County, Warm Springs, Russian

Stabilization of streambanks along creeks and rivers throughout Califonia is an important means of protecting agricultural land from erosion. Bank stabilization treatments have been installed in varistabilization treatments nave oeen instance in various locations along Dry Creek, primarily at mean-ders to absorb the erosional energy of the stream, deflect the current or both. The 14 mile long lower section of the creek, from Warm Springs Dam to the Russian River in Sonoma County was studied. Both the stabilization technique used and the harshness of the site determine the success of estabharshness of the site determine the success of estab-lishment. Bank stabilization with car bodies, wire fencing, and willow planting have not prevented the establishment of native riparian woodland spe-cies along Dry Creek. Wood fencing and the use of concrete rubble have led to the establishment of willow types without further successional develop-ment so far. Tire and rock riprapping and bamboo planting, however, have not provided environ-ments where native riparian species can become established. Factors found to influence the estab-lishment potential on stabilized areas include the erosional environment, available soil moisture. instituted potential of standard areas include are recisional environment, available soil moisture, light, competition, position of the bank, and flow velocity. (Baker-IVI) W84-03220

#### 5. WATER QUALITY MANAGEMENT AND **PROTECTION**

#### 5A. Identification Of Pollutants

DETERMINATIONS IN GROUND WATER, Illinois State Water Survey Div., Champaign.

M. J. Barcelona. Ground Water, Vol. 22, No. 1, p 18-14, January-February, 1984. 1 Fig, 4 Tab, 26 Ref.

Descriptors: \*Organic carbon, \*Groundwater pollution, \*Pollutant identification, Chemical analysis, Volatile solids, Organic compounds, Monitoring.

#### Field 5—WATER QUALITY MANAGEMENT AND PROTECTION

#### Group 5A-Identification Of Pollutants

Determinations of total organic carbon (TOC) can provide valuable diagnostic evidence of the extent of ground-water contamination by organic com-pounds. The usefulness of conventional TOC reor ground-water contamination by organic com-pounds. The usefulness of conventional TOC re-sults in monitoring efforts is limited by the bias introduced during the purging of inorganic carbon prior to analysis. A modified TOC procedure perprior to analysis. A modified TOC procedure permits the quantitation of the volatile organic carbon (VOC) fraction in water samples. The methodology consists of trapping the VOC in a manner analogous to commercial purge and trap instruments which are used for specific organic component spearations. The method is sensitive, accurate and reasonably precise for TOC determinations of standard solutions as well as on ground-water samples. Volatile organic carbon levels can water samples. Volatile organic carbon levels can range from 9-50% of the TOC in both uncontaminated and contaminated ground waters. The reporting of the volatile and nonvolatile fractions of the TOC will enhance both monitoring and research efforts, since it permits more complete characterization of the organic carbon content of ground-water samples. (Murphy-IVI) W#4-03074

RELATIONSHIPS BETWEEN GROUND-WATER SILICA, TOTAL DISSOLVED SOLIDS, AND SPECIFIC ELECTRICAL CONDUCTIVI-

Agricultural Research Service, Fresno, CA. Water Management Research I ab

Management Research Lab.
B. A. Day, and H. I. Nightingale.
Ground Water, Vol. 22, No. 1, p 80-85, January-February, 1984. 4 Fig. 6 Tab, 19 Ref.

Descriptors: \*Conductivity, \*Groundwater, \*Water quality, \*Dissolved solids, \*Silica, California, Fresno, San Joaquin Valley.

Specific electrical conductivity (SEC), total dissolved solids (TDS), and silica (SiO2) are groundwater quality parameters routinely measured in a laboratory. Electrical conductivity measurements are made quickly and are less costly than TDS measurements. Once the relationship between the measurements. Once the relationship between the parameters is determined by regression analysis, TDS can be estimated quickly from the SEC and SiO2 measurements. Water quality data from 25 city wells in Fresno, California, and historical ground-water quality data from the adjacent San Joaquin River/Kings River alluvial interfan (central San Joaquin Valley, California), the Kaweah River alluvial fan, and the Kern River alluvial fan (southern San Joaquin Valley) were used in this investigation. For the specific hydrologic areas studied, the model's TDS predictive ability is improved when SiO2 is included with SEC as the independent variables, Cauthor's abstract) independent variables. (Author's abstract)

LONGITUDINAL DISPERSION IN NATURAL

Natural Systems Research, Hawthorn (Australia). To Beer, and P. C. Young.

Journal of Environmental Engineering, Vol. 109,
No. 5, p 1049-1067, October, 1983. 6 Fig, 48 Ref.

Descriptors: \*Longitudinal dispersion, \*Natural streams, Time series analysis, Pollution load, Comparison studies. Fikian model

When time-series methods of parameter estimation are used to model the concentration of a pollutant in a natural waterway, the results may be grouped in a natural waterway, the results may be grouped into a restricted class of models which are termed (j,n,m) models. The dispersion, as represented in conservative forms of these models, has a temporal variance that increases linearly with time (thus mimicking the variance of a Fickian process) and is consistent with dead zone mixing within rivers and streams. A variety of rivers demonstrate that the (j,n,m) model provides an explanation of actual data that is superior to those obtained by manipulation of a Fickian equation. In addition, the model greatly simplifies computation of dead zone dispersive effects, is able to simply deal with non-consive effects, is able to simply deal with non-con-servative pollutants and the results suggest that residence times are more meaningful physical parameters than dispersion coefficients in explaining dispersive phenomena. (Murphy-IVI) W84-03087

COMPARISON OF BASIN PERFORMANCE MODELING TECHNIQUES,

Espey, Huston and Associates, Inc., Austin, TX. Environmental Engineering Div. G. F. Goforth, J. P. Heaney, and W. C. Huber. Journal of Environmental Engineering, Vol. 109, No. 5, p 1082-1098, October, 1983. 10 Fig, 6 Tab,

Descriptors: \*Comparison studies, \*Basins, \*Performance evaluation, \*Model testing, Water pollution control, Storm water, Water management, Runoff volume, Stormwater detention basins, Drawdown, Drainage area.

Combined and separate storm sewer overflows contribute similar magnitudes of contaminant loads to receiving waters as does secondary treatment effluent. A comparison of methods used for analyzeffluent. A comparison of methods used for analyzing the long-term pollutant removal efficiency in a stormwater detention basin points out some fundamental differences between simulation, using EPA's Storm Water Management Model, and a statistical technique advanced by Hydroscience, Inc. For the 24.6-yr record of Atlanta, Georgia hourly rainfall, the mean runoff event volume predicted by each method is similar. However, the inability of the statistical method to account for the reduction in the number of events (due to indigeneed) reduction in the number of events (due to indigereduction in the number of events (due to indige-nous catchment storage) results in an estimate of total runoff 30% greater than the simulation re-sults. The statistical technique employs a pollutant removal expression applied to the total flow cap-tured in the detention basin, as contrasted to the simulation utilization of intra-event pollutant kinet-ics. Catchment and the state of the s ics for removal within the basin. Solution surfaces ics for removal within the basin. Solution surfaces of runoff flow capture and pollutant removal efficiencies are developed for each method as a function of basin volume and drawdown rate. The differences in performance estimates between the two methods increase as the basin volume and drawdown rate increase, with the statistical technology. inque yielding the lower estimate of flow capture. For a long-term pollutant removal efficiency of 70%, the annual cost associated with a basin designed by the statistical technique is approximately twice that of a basin designed by simulation. The program SYNOP generates rainfall event statistics which may be incorporated with simulation, providing a coordinated approach for analyzing the performance of stormwater detention basins.

SPECTROPHOTOMETRIC DETERMINATION OF NITRITE IN NATURAL FLOW INJECTION ANALYSIS,

Okayama Univ., Kurashiki (Japan). Inst. for Agricultural and Biological Sciences. S. Nakashima, M. Yagi, M. Zenki, A. Takahashi,

Analytica Chimica Acta, Vol. 155, p 263-268, December, 1983. 5 Fig, 1 Tab, 8 Ref.

Descriptors: \*Nitrite, \*Pollutant identification, Water analysis, Spectrophotometry, Flow injection, Natural waters, Lakes, Ponds, Irrigation water, Rain water, Well water.

Rapid, sensitive, and accurate methods of determining nitrite in natural waters are essential in environmental chemistry, geochemistry and limology. This method is suitable for the determination of low microgram/liter levels of nitrite in non or low microgram/iter levels or nutrite in waters. Nitrite diazotizes p-aminoacetophenone and the product is coupled with m-phenylenediamine at 30 degrees C. The limit of detection is 0.2 micrograms/liter for sample injections of 650 microliters. The sampling rate is about 30/hr and the relative standard deviation is less than 1.3%. This method was successful in determining nitrite at 100 m. micrograms reselitor levels in eather lawters. low micrograms per liter levels in natural waters taken from rivers, lakes, ponds, and wells as well as rain water and irrigation water samples. (Murphy-IVI) W84-03109

ROUND ROBIN INVESTIGATION OF METH-ODS FOR THE RECOVERY OF POLIOVIRUS FROM DRINKING WATER,

Baylor Coll. of Medicine, Houston, TX. J. L. Melnick, R. Safferman, V. C. Rao, S. Goyal, and G. Berg.

Applied and Environmental Microbiology, Vol. 47, No. 1, p 144-150, January, 1984. 6 Tab, 30 Ref.

Descriptors: \*Experimental design, \*Poliovirus, \*Potable water, Water quality control, Water quality, Water analysis, Hydrologic data collections, Adsorption, Viradel-organic flocculation, Filters,

Six laboratories actively involved in water virology research participated in a methods evaluation study, conducted under the auspices of the American Society for Testing and Materials Committee on Viruses in the Aquatic Environment, Task Force on Drinking Water. Each laboratory examined the Viradel (virus adsorption-elution) method with cartridge-type Filterite filters for virus adsorption and organic flocculation and aluminum hydroxide-hydroextraction for reconcentration. The quantity of virus recovered from four 100-liter samples of dechlorinated tapwater seeded with low (350 to 860 PFU) and high (1,837 to 4,689 PFU) doses of poliovirus type 1, were in considerable doses of poliovirus type 1, were in considerable variation. The Viradel-organic flocculation method had an average percentage virus recovery for low-input experiments of 66%, with a range of 8 to 20% in two laboratories, 49 to 63% in three laboratories, and 198% in one laboratory. For the high input experiments two laboratories for the laboratories are preparated to be a considerable with the laboratories of the laboratories and 198% in one laboratory. For the laboratories, and 198% in one laboratory. For the high-input experiments, two laboratories had recoveries of 6 to 12%, and four laboratories had recoveries of 26 to 46%. For the Viradel aluminum hydroxide-hydroextraction procedure, two laboratories recovered 9 to 11%, whereas four obtained 17 to 34% for low-input experiments. For the high-input tests, two laboratories had a recovery of 3 to 5%, and four recovered 11 to 18% of the seeded virus. Each laboratory was also encouraged to test other methods reported to be useful and reliable, but which had not been widely used. Other methods tested such as magnetic iron oxide. "Virozorb' objects of the seeded virus consideration of the seeded virus of the seeded virus." ods tested such as magnetic iron oxide, 'Virozorb' electropositive filters, Virozorb filters in combination with membrane filters, and membrane disks alone, had average virus recoveries of 36, 20, 0.4, and 5%, respectively. Possible differences in quality of the water in which the virus was diluted and in the quality of the eluents are some of the variables suspected for the wide differences in virus recovery results from different laboratories. Nevertheless, there was sufficient consistency among four of the six laboratories for the task force to recommend the Viradel-organic floculation pro-cedure as a provisional method for the recovery of human enteroviruses from drinking (Murphy-IVI) W84-03110

A COLUMN TECHNIQUE FOR DETERMINING SORPTION OF ORGANIC SOLUTES ON THE LITHOLOGICAL STRUCTURE OF AQUIFERS, Geological Survey, Menlo Park, CA.

D. F. Goerlitz.

Bulletin of Environmental Contamination and Toxicology, Vol. 32, No. 1, p 37-44, January, 1984. 2 Fig, 1 Tab, 15 Ref.

Descriptors: \*Organic compounds, \*Aquifers, \*Pollutant identification, Contaminants, Chromatography, Groundwater pollution.

It is estimated that presently some 6.5 billion cubic meters of contaminated liquids infiltrate our ground water each year. Waste dumps and chemical impoundments are primary contributors to the contamination. There are apparent problems in the batch sorption determination and uncertainties in the indirect octanol-water partition, organic-carbon method. Alternative sediment-column tech-nique uses readily available high performance liquid chromatography equipment thus permitting automation of the elution and effluent monitoring. This method was convenient, reproducible, and closely resembles ground water-transport mechanism. The sorption behavior of organic solutes in aquifer material was readily determined by evaluation of the elution histories of sediment columns. The heretofore difficult technique has been made practical through the use of high pressure liquid

#### WATER QUALITY MANAGEMENT AND PROTECTION—Field 5

#### Identification Of Pollutants-Group 5A

chromatography technology. The ability to select a solution concentration of column to the sediment test column permits wide flexibility for evaluation. The need for a minimum amount of attention during the experiment is also this technique. (Murphy-IVI) W84-03129 ent is also a valuable feature of

BAKER'S YEAST ASSAY PROCEDURE FOR TESTING HEAVY METAL TOXICITY,

FIGURE HEAVY METAL TOXICITY, Florida Univ., Gainesville. Dept. of Environmental Engineering Sciences.

G. Bitton, B. Koopman, and H. D. Wang.
Bulletin of Environmental Contamination and Toxicology, Vol. 32, No. 1, p 80-84, January, 1984.

1 Fig. 2 Tab, 14 Ref.

Descriptors: \*Pollutant identification, \*Water analysis, Yeast, Cultures, Heavy metals, Copper, Zinc, Mercury, Nickel, Silver, Metals.

As a result of the entry of thousands of chemicals into the aquatic environment, there is a need for rapid screening of chemical toxicity. A toxicity assay for heavy metals using commercial dry yeast assay for heavy metals using commercial dry yeas as the test microorganism was most sensitive for copper and was intermediate in sensitivity for mer-cury, zinc, and nickel. Only in the case of mercury was the sensitivity of the bakers' yeast assay proce-dure less than 40% that of the most sensitive dure less than 40% that of the most sensitive alternative toxicity assay. Bakers' yeast is readily available from commercial sources, is inexpensive and stable at room temperature for long periods. No tedious and time consuming culture techniques are needed. The cells can be easily observed using a low cost compound microscope. (Murphy-IVI) W84-03131

DETERMINATION OF CHLORINE DIOXIDE, CHLORINE, CHLORITE AND CHLORATE IN WATER, Stanford Univ., CA. Dept. of Civil Engineering. E. M. Aieta, P. V. Roberts, and M. Hernandez. Journal of American Water Works Association, Vol. 76, No. 1, January, 1984. 7 Tab, 24 Ref. EPA grant R-808686.

Descriptors: \*Pollutant identification, \*Monitoring, Wastewater treatment, Chlorine, Chlorine dioxide, Chlorite, Chlorate, Drinking water, Disinfection, Water treatment, Titration, Potentiometry,

Chlorine dioxide is an attractive alternative for chlorine in drinking water disinfection, because it effectively inactivates bacteria and viruses over a broad pH range, does not produce trihalomethanes and provides a measurable residual. A procedure herein which is used for either amperometric or potentiometric determination of iodine is formed by the oxidation of iodide by chlorine dioxide, chlorine, chlorite, and chlorate. Either phenylarine oxide or sodium thosulfate can be used as the sine oxide or sodium thiosulfate can be used as the titrant. Sample pretreatment and pH adjustment differentiate among the various chlorine species. The method can be adapted to characterize either The method can be adapted to characterize either feed and product streams of chlorine dioxide generators (typical concentration range of individual species: 10-1000 mg/L) or treated drinking water (typical concentration range: 0.1-1 mg/L). The detection limits in drinking water are felt to be about 0.05, 0.02, 0.02, and 0.25 mg/L for chlorine dioxide, chlorine, chlorite, and chlorate, respectively. The sensitivity and precision represent a substantial improvement over other methods in use. In the high concentration range precision was good. In the low concentration range the method should prove helpful in monitoring the dosage of chlorine dioxide and in studying the transformations of oxidized chlorine species in treated waters and distribution systems. (Murphy-IVI) W84-03141

RECULTIVATION OF LAKE MUTEK - ENVI-RONMENTAL AND FISHERY ASPECTS Instytut Rybactwa Srodladowego, (

Kortowo (Poland). J. A. Szczerbowski, K. Lossow, H. Gawronska, S.

Niewolak, and J. Sosnowska. Polskie Archiwum Hydrobiologii, Vol. 30, No. 2, p 103-140, 1983. 17 Fig, 6 Tab, 82 Ref.

Descriptors: \*Lake Mutek, \*Poland, \*Environ-mental effects, \*Lake fisheries, \*Aeration, \*Lake restoration, Chemical properties, Microorganisms, Phytoplankton, Macrophytes, Zooplankton,

Lake aeration and intensive fishery management allowed for better and more effective utilization of the existing production potential. The aeration process at Lake Mutek (1977-1980) prevented formation of the thermocline and increased tempera-ture of over-bottom water layers to about 17 C. Lake aeration induced only slight changes in the sediments from shallow lake areas, accelerating processes of mineralization. The number of phytoplacesses of mineratzation. The number of phyto-plankton species decreased during aeration, while phytoplankton biomass doubled in 1978, increased four-fold in 1979, but decreased in the last year to levels lower than in the control year. The biomass levels lower than in the control year. The biomass of emerged and submerged vegetation increased by about 25%. The annual biomass of planktonic crustaceans almost doubled, and the vertical range of zooplankton occurrence became wider. The density and biomass of bottom fauna in the littoral and sublittoral zone noticeably increased, but in the profundal zone they decreased. Aeration, as a method of lake recultivation, had an effect upon physical and chemical properties of water, microorganisms, phytoplankton, macrophytes, zooplankton, bottom fauna and fishes. (Murphy-IVI) W84-03153

IDENTIFICATION AND DETERMINATION OF POLYCHLORINATED BIPHENYLS BY HIGH-RESOLUTION GAS CHROMATOGRA-

PHY, National Water Research Inst., Burlington (Ontar-io). Analytical Methods Div. F. I. Onuska, R. J. Kominar, and K. A. Terry. Journal of Chromatography, Vol. 279, p 111-118, 1983. 3 Fig, 4 Tab, 11 Ref.

Descriptors: \*Polychlorinated biphenyls, High-resolution gas chromatography, Computers, Chemical analysis, Water sampling, Pollutant identification,

An integrated analytical procedure for polychlori-nated biphenyl (PCB) multiresidues in sediment samples enables quantitation of PCB residues at levels as low as 0.1 microgram/kg in sediments. PCB residues are characterized and quantified by wall-coated open-tubular column gas chromatogra-phy with electron-capture detection. An automat-ed data system, based on a Spectra Physics SP-4100 computing integrator, selects and quantitates peaks of individual isomers and homologous groups of PCBs. Interferences from the DDT group. organochlorine compounds and Mirex can group, organochlorine compounds and Mirex can easily be identified and subtracted from the chromatogram. The procedure consistently yields results with a reproducibility within 3%. (Murphy-IVD W84-03157

POSSIBILITIES AND LIMITATIONS OF TRACING INDUSTRIAL EFFLUENTS IN THE SEA BY MEANS OF CAPILLARY CHROMA-

TOGRAPHY, Chalmers Univ. of Technology, Goeteborg (Sweden). Dept. of Analytical and Marine Chemis-

B. Josefsson.

Journal of Chromatography, Vol. 279, p 119-123, 1983. 1 Fig, 13 Ref. Descriptors: \*Tracers, \*Effluents, \*Chromatogra-

phy, \*Industrial wastes, Capillary chromatogra-phy, Water analysis, Seawater, Chlorophenols, Halogenated hydrocarbons.

Certain organic constituents of waste water, such Certain organic constituents of waste water, such as halocarbons and chlorophenols, can be used to establish the distribution pattern of effluents discharged into the sea. The approach requires simple sampling techniques and highly sensitive and rapid analytical methods. The combination of glass capillary column gas chromatography and electron-capture-detection meets the analytical requirements. The selectivity of the detector, together with the high resolving power of the column with the high resolving power of the column,

makes it possible to handle the complex sea-water matrix. Selective derivatization directly in the water sample is combined with simultaneous extraction to increase the number of suitable tracers. Halocarbons can be measured at pg/l levels. Chlorophenols are determined at ng/l concentration levels. (Author's abstract) W84-03158

DIRECT DETERMINATION OF TRACE AMOUNTS OF CHLOROPHENOLS IN FRESH WATER, WASTE WATER AND SEA WATER, Chalmers Univ. of Technology, Goetebor, (Sweden). Dept. of Analytical and Marine Chemis Goeteborg

K. Abrahamsson, and T. M. Xie. Journal of Chromatography, Vol. 279, p 199-208, 1983. 8 Fig, 2 Tab, 11 Ref.

Descriptors: \*Chlorinated phenols, \*Water analysis, \*Wastewater analysis, \*Seawater, Gas chromatography, Phenols, Pulp wastes, Drinking water, Acetylation.

Chlorophenols were acetylated and the derivatives extracted by the simultaneous addition of acetic anhydride and hexane directly to the water sample. The extracts were then analysed by glass capillary column gas chromatography with electron-capture detection. Determination of chlorinated phenols at detection. Determination of chlorinated phenols at micro g/l concentration levels requires only 5 ml of sample. At ng/l levels a 100-ml sample is suffi-cient. The total time of analysis is 18 min per sample. A comparison between pentafluorobenzoy-lation and acetylation showed that the acetylated derivatives of chlorophenol isomers separated better on the column. The method has been applied to drinking water, sea water and waste water from a sulfate pulp mill. (Author's abstract) W84-03160

QUANTITATION OF ENVIRONMENTAL CONTAMINANTS BY FUSED-SILICA CAPILLARY COLUMN GAS CHROMATOGRAPHY-MASS SPECTROMETRY WITH MULTIPE INTERNAL STANDARDS AND ON-COLUMN

Freshwater Fisheries Lab., Pitlochry (Scotland). D. E. Wells, and A. A. Cowan. Journal of Chromatography, Vol. 279, p 209-218, 1983. 1 Fig, 6 Tab, 14 Ref.

Descriptors: \*Pollutant identification, \*Gas chromatography, \*Mass spectrometry, \*Internal standards, Pesticides, Herbicides.

The on-column injector to the gas chromatogra-phic-mass spectrometric (GC-MS) instrument had superior quantitative results when compared with the splitless injection, particularly for less volatile, non-polar herbicides and pesticides. The final sample solvent can be selected on the basis of the desired chromatographic separation to give shorter analysis times and minimal delay between injections. The precision in peak retention times and areas in markedly improved by the use of multiple internal standards, eluted within ten minutes of the analyte. Many of the internal standards selected may be used with GC-MS, gas chromatographyelectron capture detection and high-performance liquid spectrometry with ultraviolet and fluores-cence detection. (Murphy-IVI) W84-03161

INVESTIGATION OF A COMPREHENSIVE APPROACH FOR TRACE ANALYSIS OF DIS-SOLVED ORGANIC SUBSTANCES IN WATER, Georgia Inst. of Tech., Atlanta, School of Civil Engineering.

M. Giabbai, L. Roland, M. Ghosal, J. H. Reuter, and E. S. K. Chian.

Journal of Chromatography, Vol. 279, p 373-382, 1983. 3 Fig, 3 Tab, 18 Ref.

Descriptors: \*Organic compounds, \*Water analysis, Drinking water, Natural waters, Trace sub-stances, Adsorption, Gas chromatography, Hydrogen ion concentration

#### Field 5-WATER QUALITY MANAGEMENT AND PROTECTION

#### **Group 5A—Identification Of Pollutants**

An isolation-fractionation scheme for the analysis of dissolved trace organic substances in natural and drinking waters was developed. The principle behind this scheme was to concentrate dissolved organic solutes and separate them into fractions by adsorption on different adsorbents (XAD-8 resin, AG-MP-50 cation-exchange resin and Carbopack B graphitized carbon black) under varying pH conditions. Test solutions containing 22 model organic substances and inorganic salts were used to monitor process performance. High-resolution gas chromatography was employed for the separation and quantitation of each model compound. Chemical derivatization procedures were established for several highly polar model compounds. Gas chromatography-mass spectrometry was used for the confirmation of compound identity in each separated fraction. (Author's abstract)

EVALUATION OF SAMPLING METHODS FOR THE DETERMINATION OF TRACE ORGANICS IN WATER,

Alabama Univ., University. Dept. of Chemistry. M. M. Thomason, and W. Bertsch. Journal of Chromatography, Vol. 279, p 383-393, 1983. 5 Fig. 3 Tab, 27 Ref.

Descriptors: \*Organic com; ounds, \*Water analysis, \*Gas-phase stripping, \*Sampling, Solvents, Thermal desorption.

The applicability of a closed-loop gas-phase stripping apparatus for the determination of trace organics in water was evaluated. Recoveries were determined for a series of n-alkanes. The effects of extraction solvent, stripping temperature, stripping time, pH and salt content on the closed-loop system were investigated. Carbon disulfide was found to be the best extraction solvent, and an extraction temperature of 40 degrees C was found to be optimal. Two water samples spiked with 0.1-0.2 and 1.0-2.0 micro g/1 of each U.S. Environmental Protection Agency base neutral priority pollulant were investigated. Recoveries for the base neutrals of the more concentrated sample were determined at 25 and 40 degrees C. A direct comparison of the closed-loop gas-phase stripping method and the purge-and-trap method with Tenax GC was performed on a river water sample. Recoveries for the thermal desorption of base neutrals from Tenax were determined at five different desorption temperatures. A new microextraction vessel, which allows the use of solvents heavier than water, was constructed and evaluated. Distribution coefficients and recoveries for compounds of different functionalities were determined at three different water to solvent ratios and at concentration levels of 100 ppb and 0.5 ppm. (Author's abstract) W84-0316-0

RESEARCH IN ENVIRONMENTAL POLLU-TION; I. DETERMINATION OF POLYCHLO-RINATED STYRENES (PCS'S) IN RHINE FISH, Hessiche Landwitzschoftliche Vermedentalt

Hessische Landwirtschaftliche Darmstadt (Germany, F.R.). H. Steinwandter, and L. Zimmer

H. Steinwandter, and L. Zimmer. Fresenius Zeitschrift für Analytische Chemie, Vol. 316, No. 7, p 705-710, December, 1983. 8 Fig, 7 Ref.

Descriptors: \*Polychlorinated styrenes, \*Rhine River, \*Fish, \*Pollutant identification, Polychlorinated biphenyls, Metabolism.

In chromatograms of extracts from fish from the Rhine River, in addition to chlorinated pesticides, the well know pattern of polychlorinated biphenyls can be seen. In the region of di-, tri- and tetrachlorobiphenyls the disappearance of certain polychlorinated biphenyl peaks indicates metabolic breakdown. The similarities between the ECD-chromatograms and HCB detect a very non-polar substance group to be present. By mass spectra and mass fragmentography the peaks were identified as polychlorinated styrene compounds. From 159 possible isomeric polychlorinated styrene compounds, 14 isomers were identified in fish. (Murphy-IVI) W84-03189

BIOASSAYS WITH STIGEOCLONIUM KUTZ. (CHLOROPHYCEAE) TO IDENTIFY NITRO-GEN AND PHOSPHORUS LIMITATIONS, Vrije Univ., Amsterdam (Netherlands). Biological

P. J. R. De Vries, M. Torenbeek, and H.

Aquatic Botany, Vol. 17, No. 2, p 95-106, October, 1983. 3 Fig, 2 Tab, 37 Ref.

Descriptors: \*Bioassay, \*Stigeoclonium, \*Nitrogen, \*Phosphorus, \*Nutrients, Chlorophyta, Eutrophication, Water quality, Seasonal variation, Polders, Netherlands.

In polder ditches, which are a characteristic of the Netherlands, eutrophication often results in abundant growth of periphyton and aquatic macrophytes. These organisms are the main producers and provide an indication of the water quality. Primarily for this aquatic environment, a suitable bioassay organism is needed and periphytic filamentous algae may be a useful addition to the range of test algae. Eleven strains of the filamentous algae genus Stigeoclonium were tested as bioassay organisms to identify nitrogen and phosphorus limitations to growth in a variety of waters. The assay results were related to the nutrient status of the waters during the year. Optimal growth was obtained at an inorganic phosphorus concentration of 0.65 mg P/I and an inorganic nitrogen concentration of 3.75 mg N/I. The algal growth potentials were generally higher in November and February than in August. Nitrogen became important as a limiting nutrient in the summer. When ratios of inorganic nitrogen to inorganic phosphorus (N/P) were above 6.2, phosphorus was primarily limiting and at lower N/P ratios nitrogen became the important limiting factor. Stigeoclonium proved to be a suitable bioassay organism to identify nutrient limitation in shallow freshwaters. (Moore-IVI)

A HIGH-SPEED LIQUID CHROMATOGRA-PHY OF PHOSPHORUS IN ANOXIC WATERS OCCURRING IN A BAY USING SOLVENT EX-TRACTION OF MOLYBDOHETEROPOLY YELLOW.

YELLOW, Hamamatsu Univ. (Japan). Dept. of Chemistry. N. Ichinose, C. Shimizu, H. Kurokura, and T. Inui. Fresenius's Zeitschrift für Analytische Chemie, Vol. 316, No. 8, p 791-792, 1983. 3 Tab, 4 Ref. Japanese Scientific Research grant 1-R16-2.

Descriptors: \*Chromatography, \*Pollutant identification, \*Phosphorus, Molybdoheteropoly yellow, Anoxic conditions, Lakes.

The deepest bottom of brackish water in lake Hamana of Japan forms an ocean basin. In this area anoxic waters are occurring in the summer with appreciable elutions of dissolved inorganic phosphorus, dissolved organic phosphorus, ferrous and other substances from the sludge in this anoxic waters. The application of high-speed liquid chromatography method can be widely employed for the rapid determination of microamounts of phosphorus, without the interference of co-existing silica, in sea and river water as well as anoxic waters. The interference of co-existing soluble silica is effectively eliminated by an extraction step. Micro-amounts of phosphrous ranging from 0.15 to 0.2 ppm in the anoxic waters can be determined rapidly and exactly (coefficient of variation 4.4%). The results agreed well with those obtained by spectrophotometry. (Baker-IVI)

A SIMPLIFIED 1,10-PHENANTHROLINE TECHNIQUE SUITABLE FOR THE DETERMI-NATION OF DISSOLVED IRON IN REMOTE SOUCES OF WATER,

Njala Univ. Coll., Freetown (Sierra Leone). Ana lytical Lab.

R. C. Wright. Freshwater Biology, Vol. 13, No. 3, p 293-296, June. 1983. 2 Tab. 4 Ref.

Descriptors: \*Iron, \*Pollutant identification, Water quality, Remote areas, Sampling.

When testing remote water sources for dissolved iron, the investigator must either use a field method or reserve a sample for subsequent laboratory determination. The latter may produce a significant alteration in the relative amounts of the different iron fractions which occur in most samples. A simplified 1,10-phenanthroline technique is useful for investigating remote sources and avoids errors due to post-sampling precipitation of hydrated ferric oxides. A small sample is added to a mixed 1,10-phenanthroline + acetate buffer solution in the field and this developed sample can then be stored for up to 4 weeks before the absorbance value is read. Average within batch precision of the technique was about 4%. Accuracy was good for streams and river samples, although a relatively large negative bias was noted for shallow-pond sample replicates. (Baker-IVI)

METALS IN THE PACIFIC SARGASSUM ALGAE AS RELATED TO WATER POLLUTION MONITORING (METALLY V SOSTAVE TIKHOOKEANSKIKH SARGASSOVYKH VODOROSLEI V SVYAZI S PROBLEMOI MONITORINGA EAGRYAENENIYA VOD),

N. K. Khristoforova, N. N. Bogdanova, and L. M.

Tolstova.
Okeanologiia, Vol. 23, No. 2, p 270-275, March-April 1983. 2 Tab, 27 Ref.

Descriptors: \*Sargassum, \*Metals, \*Monitoring, Water pollution effects, Marine algae, Iron, Manganese, Copper, Zinc, Lead, Cadmium, Pacific Ocean.

The concentrations of the metals Fe, Mn, Cu, Zn, Pb and Cd, in sargassum are discussed in connection with the intensity of anthropogenic loading on their habitats. According to the mineral composition of algae, the quality of coastal waters of some Pacific regions is characterized. It is shown that Mn concentration in the algae depends on the illumination conditions rather than on the environmental geochemical factors, and that sargassums seem to be capable of regulating the accumulation of this metal. (Author's abstract)

AUTOMATED RAIN SAMPLER FOR TRACE ORGANIC SUBSTANCES,

National Water Research Inst., Burlington (Ontario). Environmental Contaminants Div.

W. M. J. Strachan, and H. Huneault. Environmental Science and Technology, Vol. 18, No. 2, p 127-130, February, 1984. I Fig, 2 Tab, 17 Ref. Department of Environment grant 9-904-EM-IWD.

Descriptors: \*Measuring instruments, \*Rainfall, \*Organic compounds, Sampling, Water sampling, Polychlorinated biphenyls, Benzene hexachloride, Lindane, Chemistry of precipitation.

An automated rain sampler was designed, built, and evaluated as a collecting device for persistent organic chemicals in rain. It consists of a large Teflon-coated funnel (0.209 sq m) with an automated lid and a Teflon column containing XAD-2 and -7 resin. The sampler was tested for recoveries and field precision with a number of organochlorine substances and PCBs frequently found at the nanogram per liter level in rain. Recoveries averaged 86% and the mean coefficient of variation for alpha-benzene hexachloride, lindane, and polychlorinated biphenyl was 33% under field conditions where samples of 0.4-22 L of rain were collected. While few quality control studies have been attempted for this type of sampler, it is felt that these results are at least as good as those from any other technique. The sampler also offers the advantage of unattended operation for extended periods, and it provides a simple method for field handling of samples since the columns can be readily exchanged and capped for delivery. (Baker-IVI) W84-03330

A MODEL OF THE DISPERSION OF SOLUBLE OF PSEUDO-SOLUBLE SUBSTANCES IN

#### WATER QUALITY MANAGEMENT AND PROTECTION—Field 5

#### Sources Of Pollution-Group 5B

WATERWAYS, APPLICATION TO THE CASE OF THE SEINE UPSTREAM OF PARIS (MO-DELISATION DE LA DISPERSION DES SUC-STANCES SOLUBLES OU PSEUDO-SOLU-BLES DANS UN COURS D. EAU. APPLICA-TION AU CAS DE LA SEINE A L'AMONT DE PARIS PARIS).

Compagnie Generale des Eaux, Paris (France). G. Bujon. Houille Blanche, No. 1, p 45-53, 1983. 7 Fig, 4 Ref.

Descriptors: \*Model studies, \*Dispersants, \*Solubility, \*Waterways, \*Seine River, Mathematical models, Mathematical studies, Simulation analysis, Pollution load, Flow characteristics.

Technicians working with water often have to anticipate changes in water quality at a given point in a waterway as a result of the permanent or temporary discharge of a polluting effluent upstream of this point. Since it is not generally possible to find a solution to this problem by experimental means (projections are often desired for low-lated flow test), it is necessity to recent to the weather the property of the property level flow rates), it is necessary to resort to the use of mathematical simulation models, which are cali-brated by means of a few preliminary experiments. The dispersion model is a bi-dimensional model established on the basis of the influence of the bands, a certain transverse variation in the field of flow speeds and the disappearance of part of the pollutant in the course of time. (Murphy-IVI) W84-03358

APPLICATION OF ULTRACLEAN SAMPLING AND ANALYTICAL TECHNIQUES TO AN INVESTIGATION OF THE IMPACT OF POWER-PLANT DERIVED HEAVY METALS ON GROUNDWATER, RIVERWATER, BOTTOM SEDIMENTS AND BENTHIC ORGANISMS, Connecticut Univ., Groton. Marine Sciences Inst. D. G. Waslenchuk. Water Science and Technology, Vol. 15, No. 11, p 223-237, 1983. 4 Fig, 8 Tab, 12 Ref.

Descriptors: \*Sampling, \*Ultraclean sampling, \*Analytical techniques, \*Powerplants, \*Heavy metals, \*Groundwater, \*Riverwater, \*Bottom fauna, Mathematical analysis, Ecological effects, Trace metals, Geochemistry, Effluents, Cooling water, Sample preparation.

At a Massachusetts power station, the routine trace metal analyses provided by private water-quality laboratories gave the impression that metal levels in stream and groundwaters adjacent to the plant were alarmingly high. The problem though is more perceived than real. Ultra-clean sampling and handling techniques from geochemical oceanographic practices, together with interpretive concepts from aquatic geochemistry had levels of metal enrichment in stream waters which were lower (eg. Cu, 2 mc/l1 than immlied by the evidently investigator-At a Massachusetts power station, the routine trace ug/l) than implied by the evidently investigator-contaminated samples (eg. Cu, 20ug/l). Employing comamnates ampies (eg. c.t., 2018/1). Employing difficult but uncompromising procedures when dealing with metals in the aquatic environment is extremely important. With accurate analyses at hand, the geochemist's 'mixing diagram' concept allows interpretation of the fate of the power-plant derived excess metals in the cooling-water discourage. Every discourage for the cooling-water discourage. charge. Excess dissolved copper disappeares due to simple and rapid dilution in the effluent river mixing zone. For bottom sediments from the adjacent Connecticut River natural processes largely explain the distribution of Cd, Cr, Cu, Fe, Mn, Ni, explain the distribution of Cd, Cr, Cu, Fe, Mn, Ni, Pb, and Zn associated with the acid leachable fraction of the sediments. No anomalous metal concentrations were among the sediments but oligochaete worms living in the sediments beneath the cooling-water plume had accumulated more metal than those elsewhere. Because tissue metal levels were unrelated to sediment metal levels, the worms may respond more to the dissolved metal load than to the sediment burden. (Murphy-IVI) W84-03380

RHODAMINE WT DYE LOSSES IN A MOUNTAIN STREAM ENVIRONMENT,

IAIN SIREAM ENVIRONMENT, Geological Survey, Menlo Park, CA. K. E. Bencala, R. E. Rathbun, A. P. Jackman, V. C. Kennedy, and G. W. Zellweger. Water Resources Bulletin, Vol. 19, No. 6, p 943-950, December, 1983. 5 Fig, 4 Tab, 18 Ref.

Descriptors: \*Tracers, \*Dye releases, \*Rhodamine dye, Mountain streams, Chloride, Lithium, Sorption, Streambeds, Gravel, Groundwater.

A significant fraction of rhodamine WT dye was lost during a short term multitracer injection ex-periment in a mountain stream environment. The conservative anion chloride and the sorbing cation lithium were concurrently injected. In-stream rho-damine WT concentrations were as low as 45% of that expected, based on chloride data. Concentra-tion data were available from shallow 'wells' dug tion data were available from shallow 'wells' dug near the stream course and from a seep of suspect-ed return flow. Both rhodamine WT dye and lithi-um were nonconservative with respect to the con-servative chloride, with rhodamine WT dye close-ly following the behavior of the sorbing lithium. Nonsorption and sorption mechanisms for rhoda-mine WT loss in a mountain stream were evaluated mine WT loss in a mountain stream were evaluated in laboratory experiments. Experiments evaluating nonsorption losses indicated minimal losses by such mechanisms. Laboratory experiments using sand and gravel size streamed sediments show an appreciable capacity for rhodamine WT sorption. The detection of tracers in the shallow wells and seep indicates interaction between the stream and the flow in the surrounding subsurface, interpravel flow in the surrounding subsurface, intergravel water, system. The injected tracers had ample opportunity for intimate contact with materials shown in the laboratory experiments to be potentially sorptive. It is suggested that in the study stream system, interaction with streambed gravel was a significant mechanisms for the attenuation of rhodamine WT dye (relative to chloride). (Au-thor's abstract) W84-03399

SEDIMENT SAMPLING IN DIFFERENT AQUATIC ENVIRONMENTS: STATISTICAL AQUATIC ASPECTS.

National Swedish Environment Protection Board,

L. Hakanson. Water Resources Research, Vol. 20, No. 1, p 41-46, January, 1984. 3 Fig, 5 Tab, 26 Ref.

Descriptors: \*Sediments, \*Sampling, \*Statistical analysis, Lake sediments, River sediments, Lead, Copper, Cadmium, Erosion, Sediment transport.

The study is based on empirical data from three different sedimentological environments: a river, a river mouth area, and a lake. The first two enviriver mouth area, and a lake. The first two environments are dominated by processes of erosion and transportation; the latter milieu is characterized by continuous accumulation of fine materials. The empirical data emanates from a regular grid of nine sites 15 m apart from the three environments. The sediment were analyzed for physical sediment character (water content and loss on ignition) and chemical/contaminational status (Pb, Cu, and Cd). The prevalent bottom dynamics influence the char-acter of the sediments and the representativity and acter of the sediments and the representativity and information value of sediment samples. An informative fraction is defined by the portion of a sediment sample that passes a 63-micro m mesh by wet sieving. This fraction corresponds approximately to deposits from areas of accumulation. Direct analysis of surficial sediment samples from areas of corresponding the property of the erosion or transportation, such as in rivers and river mouths, yield low information, i.e., many samples would be required to obtain a given statissamples would be required to obtain a given statistical certainty. Correction with the water content (or similar parameters, e.g. grain size and bulk density) or organic content would improve the information but still not yield optimal results. Simple wet sieving through a 63-micro m mesh seems to yield best information, i.e., the lowest number of necessary analysis for the least amount of work. Fractionated centrifugation (or similar approach, e.g., ultrafiltration) would not improve the information value. (Moore-IVI)

NONPARAMETRIC TESTS FOR TREND IN WATER QUALITY,

Washington Univ., Seattle. G. van Belle, and J. P. Hughes. Water Resources Research, Vol. 20, No. 1, p 127-136, January, 1984. 2 Fig, 5 Tab, 22 Ref, 1 Append. Descriptors: \*Water quality, \*Trend, \*Statistical analysis, \*Nonparametric tests, Data analysis, Seasonal variation, Errors.

Nonparametric tests for trends in water quality have been developed because the assumptions of classical parametric methods (i.e., normality, linearity, independence) are usually not met by typical water quality data. Additional idiosyncrasies of the data, such as missing values, censored data, and seaonality, compound the analysis problem. The nonparametric methods are more flexible and can handle these problems more easily. Two classes of procedures, intrablock methods (procedures that compute a statistic, such as Kendall's tau, for each block or season and then sum these to produce a single overall statistic), and aligned rank methods (procedures that remove the block effect from each datum, sum the data over blocks, and then create a statistic from these sums) are examined in Nonparametric tests for trends in water quality create a statistic from these sums) are examined in detail. Aligned rank methods are asymptotically more powerful than intrablock methods, but intrablock methods are more adaptable. Procedures tranfock methods are more adaptates. Procedures to analyze more general models, including multistation designs and models, which include a trendseason or trend-site interaction, are developed by using Kendall's tau and intrablock methods. For the analysis of data sets with missing values and multiple values per season values, some possible solutions are adjustment of season length by using solutions are adjustment of season length by using a uniform site series consisting of summary statistics, discarding extra observations, filling in missing observations with estimated values, or considering data collected in the same season as tied and using a modified version of tau. The appropriate procedure will depend on the individual data set, but basic statistical concerns include retention of the properties of homoscedasiticy (equal residual errors) and independence. (Moore-IVI) W84-03419

ENTERIC VIRUSES IN NEW ZEALAND WASTEWATERS, Otago Univ., Dunedin (New Zealand).
R. S. Simmonds, M. W. Loutit, and F. J. Austin. New Zealand Journal of Science, Vol. 26, No. 4, p 437-441, 1983. 2 Tab, 19 Ref.

Descriptors: \*Viruses, \*Wastewater, New Zealand, Pollutant identification, Water treatment, Chlorination, Disinfection, Public health.

The most important disease-causing enteric viruses cannot be readily cultured from environmental samples, but the examination of water and wastewater for the presence of enteroviruses does provide a reliable indication of the presence of provide a reliable indication of the presence of infectious virus. Samples from wastewater and treatment plants were tested for human enteroviruses after concentration by adsorption to and elution from bentonite. Nine different viruses were detected in 36 samples at concentrations ranging up to 4000 plaque forming units per liter. Included in the 9 were poliovirus types 1, 2, and 3; coxsackeivirus types B2, B4, and B5; and echovirus types 21, 24, and 25. While virus numbers were reduced by chlorine treatment they were still detectable in by chlorine treatment they were still detectable in 11 of the 16 chlorinated samples. Viruses were detected at considerable distances from the point of discharge, and the possibility of sporadic u tected infection exists. (Baker-IVI) W84.03486

#### 5B. Sources Of Pollution

THE DISTRIBUTION AND ACCUMULATION OF ALUMINUM IN RAINBOW TROUT FOL-LOWING A WHOLE-LAKE ALUM MENT.

Eastern Washington Univ., Cheney. Dept. of Biol-

ogy. P. M. Buergel, and R. A. Soltero. Journal of Freshwater Ecology, Vol. 2, No. 1, p 37-44, March, 1983. 3 Tab, 11 Ref.

\*Bioaccumulation, \*Aluminum. Descriptors: Rainbow trout, Whole-lake treatment, \*Aluminum sulfate, Ecological effects, Bioindicators, Lake restoration, Chemical analysis, Chemical composition.

#### Field 5-WATER QUALITY MANAGEMENT AND PROTECTION

#### Group 5B-Sources Of Pollution

Medical Lake, Spokane County, prior to 1977, was subject to high phosphorus concentrations manifested by reduced sediments. Phosphorus inactivation was accomplished by the appliation of 936 metric tons of alum (aluminum sulfate). The immediate and long-term effects of an alum treated environment upon the food chain are generally unknown. Because there has been a deliberate al-teration in the natural chemistry of Medical Lake by the alum treatment, there is potential for a bioacumulation of aluminum by organisms inhabit-ing the lake. Because the fish and their prey are ing the last. Because the last and then prey are dependent upon a habitat potentially higher in available aluminum than neighboring habitats, trout tissues, plankton and water were analyzed for total aluminum concentrations. Statistical comparisons of experimental and control tissues revealed few overall significant differences (P=0.05) in the new overant significant differences (P = 0.05) in the level of aluminum between alum-exposed and non-exposed fish, but significant differences existed between tissues within a given treatment and age class. (Murphy-IVI) W84-02963

LEAD IN DRINKING WATER-INVESTIGA-TION OF A CORROSIVE WATER SUPPLY, Morris Township Health Dept., Convent Station,

For primar W84-02983 ary bibliographic entry see Field 5F.

RUNOFF FRACTION AND POLLUTION LEVELS IN RUNOFF FROM A WASTE ROCK DUMP UNDERGOING PYRITIC OXIDATION, Australian Atomic Energy Commission Research Establishment, Sutherland. Environmental Science

J. R. Harries, and A. I. M. Ritchie. Water, Air and Soil Pollution, Vol. 19, No. 2, p 155-170, 1983. 9 Fig, 1 Tab, 20 Ref.

Descriptors: \*Rainfall-runoff relationships, \*Acid drainage, \*Mine wastes, Pyritic oxidation, Oxidation, Water pollution sources, Mine drainage, Dumps, Waste dumps.

A series of measurements was carried out during the 1975-76 and 1976-77 wet seasons, in which the rainfall incident on a waste rock dump, the fraction of rain that appeared as runoff, and the pollution levels in the runoff during runoff events were determined. Rainfall/runoff data was scattered about a curve that could be used to predict the average runoff response of the waste rock dump to rainfall on it. Although a runoff fraction as high as rainfall on it. Although a runoff fraction as high as 33% was observed, the runoff fraction was in general quite low, with an average of 15% over the two wet seasons monitored in detail. Although the concentration of pollutants in runoff varied in a characteristic way throughout the discharge events monitored, there were insufficient data of sufficient precision to produce a well defined concentration level/runoff relationship for the dump that could be used in modeling the interaction between runoff water and the dump surface. Present data do show. water and the dump surface. Present data do show, however, that pollutant levels are largely insensitive to the rainfall pattern during the wet season and to the long rainless period during the dry season. The insensitivity of pollutant levels to the season. The insensitivity of pollutant levels to the history of rainfall on the dump allows meaningful average pollutant levels to be evaluated and used to predict the annual pollutant load in runoff from the dump. (Baker-FRC) W84-02987

STUDIES ON BACTERIOLOGICAL QUALITY OF NAINITAL LAKE WATER IN DIFFERENT SEASONS.

SEASONS, Kumaun Univ., Naini Tal (India). MAB/DST Lakes Project. J. Pande, S. M. Das, and D. S. Misra. Water, Air, and Soil Pollution, Vol. 19, No. 2, p 149-154, 1983. 1 Fig, 1 Tab, 9 Ref.

Descriptors: \*Water quality, \*Coliforms, \*Bacteria, \*Public health, Recreational water, India, Fecal contamination, Rain, Monsoons.

The density of total coliforms and E. coli in Nainital lake was measured in different sea

1978-79. The study was undertaken as a public health investigation as Lake Nainital is visited by more than 100,000 tourists each year and has a local population of 30,000. The raw water of this lake is used for domestic supplies as well as for recreational purposes by tourists and residents. The coliform count of entire lake water showed a distinct seasonal variation. The highest value of coliforms was observed during the rainy season while forms was observed during the rainy season while it was lowest in the winter months. It is believed that during the monsoon months the surface water drained from the surrounding areas of the lake probably added additional waste water from human habitation which could be the main cause for the high coliform count of lake water during the rainy season. This increase was probably due to increased human or animal activity. While there increased numan or animal activity. what here are no Indian Standards for recreational water quality, it is recommended that the total coliform count of 1000 and 5000/100 ml be the limiting values for contact and noncontact recreational waters, respectively, and that the corresponding values of 150 and 750/100 ml for E. coli be established for expective the probability recognition of the coling of the content of the conten lished for assessing the probable exposure to patho-genic organisms. The present high values of coli-forms and E. coli of Nainital Lake could be considered a direct health menace, particularly in the summer season. (Baker-FRC) W84-02989

PCB CONTAMINATION IN AND AROUND NEW BEDFORD, MASS, Norwich Dept. of Public Utilities, CT. G. Weaver.

Environmental Science and Technology, Vol. 18, No. 1, p 22A-27A, January, 1984. 1 Fig. 2 Tab, 5

Descriptors: \*Polychlorinated biphenyls, \*Harbors, New Bedford, Massachusetts, Wastewater treatment facilities, Industrial wastes, Hudson River, Waukegan, Illinois, Bloomington, Indiana, Georges Bank.

New Bedford is the largest revenue-producing fishing port on the United States Atlantic seaboard. This community is bounded by the Acushnet River estuary, New Bedford Harbor, and Buzzards Bay. Past use of polychlorinated biphenyls has left a lasting effect on the vibrant port. Contamination of the Harbor was first noted in 1976. Testing revealed two industrial operations discharging wastewaters containing PCBs. Sediments underlying the entire 440 harbor contain elevated levels of PCBs. Widespread contamination of the Acushnet River estuary and environs resulted in the closing River estuary and environs resulted in the closing of the area to fishing. Located at the southern terminus of Clark's Point, the New Bedford wastewater treatment plant discharges a daily average of 10 to the 8th power liters of primary treated wastewater to Buzzards Bay. No decrease in PCB content is obvious following treatment. In addition to these sources of PCB contamination, other as yet unidentified dischargers exist. Some abatement procedures have been implemented but the fate of the extensive harbor water quality is still unknown. (Baker-IVI) W84-03031

NONREVERSIBLE SORPTION OF PHENOLIC COMPOUNDS BY SEDIMENT FRACTIONS: THE ROLE OF SEDIMENT ORGANIC MATTER,

Connecticut Agricultural Experiment Station, New Haven.

P. J. Isaacson, and C. R. Frink. Environmental Science and Technology, Vol. 18, No. 1, p 43-48, January, 1984. 6 Fig, 2 Tab, 29 Ref.

Descriptors: \*Sediments, \*Organic matter, \*Phenols, Sorption, Hydrogen, Bonding, Chlorophenol, Dichlorophenol, Fate of pollutants.

environmental fate of many organic chemicals will be determined largely by their sorption inter-actions with soils or sediments. The organic matter content of natural sorbents is shown to be an important factor in determining their sorption properties. The sorption and desorption of phenol, 2-chlorophenol, and 2,4-dichlorophenol by a fine and coarse sediment fraction were measured in a

continuous flow stirred cell. The sorption of up to continuous flow stirred cell. The sorption of up to 0.3 mmol/g of sorbent was not due solely to hydrophobic interactions. Desorption was slower than sorption, and in some cases up to 90% of the sorbate was irreversibly held. The extensive hysteresis between sorption and desorption shows that the desorption process is affected by the previous sorption. The penetrability and accessibility of organic matter associated with sediment are a major influence in the sorption of compounds which take part in extensive hydrogen-bond interactions. (Murphy-IVI) W84-03035

CHEMISTRY AND MICROBIOLOGY OF A SEWAGE SPILL IN SOUTH SAN FRANCISCO

Geological Survey, Menlo Park, CA. For primary bibliographic entry see Field 5C. W84-03038

TURBIDITY INTERFERES WITH ACCURACY IN HEAVY METALS CONCENTRATIONS.

S. Stausberg. Industrial Wastes, Vol. 29, No. 2, p 16-21, March/ April, 1983. 2 Fig.

Descriptors: \*Industrial wastes, \*Heavy metals, \*Turbidity, Monitoring wells, Wells, Groundwater, Groundwater pollution, Groundwater manage-

Heavy metal concentrations in groundwater at a nine-acre non-ferrous metal plant in the northern part of the Atlantic Coastal Plain are largely atpart of the Atlantic Coastal Plain are largely attenuated by interstitial claysand silts in the shallow
aquifer underlying the plant. Most of the groundwater originating from infiltration in the plant's
grounds is discharged through the shallow aquifer
consisting of Pleistocene silty sands and gravels
that are interspersed with silty clay lenses. To
improve water quality samples taken in the area, an
intensive well redevelopment program was undertaken in the spring of 1980 to increase well diameters by removing silt and clay from the aquifer
outside the gravel pack and stabilize the aquifer
sand, mainly at the interface. After redevelopment,
sample analysis indicated that the 1979 water samples had turbidity levels more than one order of
magnitude higher. (Baker-IVI) W84-03041

CATTLE GRAZING IMPACT ON SURFACE WATER QUALITY IN A COLORADO FRONT RANGE STREAM,

Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO.

Journal of Soil and Water Conservation, p 124-128, March-April, 1983. 3 Fig, 3 Tab, 23 Ref.

Descriptors: \*Surface water, \*Water pollution sources, \*Grazing, \*Cattle, \*Colorado, Suspended solids, Ammonia, Bacteria, Eutrophication, Manure, Water quality.

Cattle grazing in pastures bisected by a small perennial stream in central Colorado had only minor effects on water quality during two years of study. effects on water quality during two years of study. Suspended solids and nitrate nitrogen did not in-crease significantly. The ammonia nitrogen in-creased significantly only once under moderates of grazing. Indicator bacteria densities in the stream water were significantly higher when at least 150 cattle were grazing. After removal of cattle or when 40 head of cattle were grazing, bacterial counts dropped to levels similar to those in an adjacent, ungrazed pasture. About 5% of the total manure produced by cattle contributed to pollution and/or enrichment of the stream. (Murphy-IVI) W84-03057

CONTAMINATION ANALYSIS - FLOW NETS AND THE MASS TRANSPORT EQUATION, Florida Atlantic Univ., Boca Raton. For primary bibliographic entry see Field 2F. W84-03076

#### Sources Of Pollution—Group 5B

IMPACT OF LAND USE ON GROUND-WATER QUALITY IN SOUTHERN DELAWARE, Delaware Univ., Newark. Dept. of Agricultural

Engineering. W. F. Ritter, and A. E. M. Chirnside. Ground Water, Vol. 22, No. 1. p 38-47, January-February, 1984. 1 Fig. 10 Tab, 10 Ref.

Descriptors: \*Land use, \*Delaware, \*Groundwater pollution, \*Nitrates, \*Water table wells, Poultry, Sussex County, Kent County, Animal wastes, Water pollution sources, Pertilizers, Septic tanks.

water poliution sources, Fertilizers, Septic tanks. In Kent and Sussex counties, ground water is the only source of water. The water-table aquifer contains most of the groundwater reserves. In the coastal areas of Sussex County excessive levels of nitrate were found in the drinking water supplies from 210 wells sampled 12 times each. In noncoastal Sussex and Kent Counties, 272 wells were sampled once each season over a period of one year. Over 99 percent of the wells were in the watertable aquifer. In coastal Sussex County, 32% of the wells had average nitrate concentrations above the EPA drinking water standard of 10 mg/l N. In noncoastal Sussex County and Kent County, 21% and 8% of the wells respectively, had nitrate concentrations occurred in areas with intensive broiler production or intensive crop production with excessively-drained soils. Nitrate concentrations in forest areas were < 1.5 mg/l. Poultry manure, septic tanks and fertilizers all contributed to the high nitrate concentrations. Poultry manure, was one of the major causes of nitrate contentions. to the high nitrate concentrations. Poultry manure was one of the major causes of nitrate contaminawas one of the major causes of intrate contamina-tion in four out of the five top prioritized ground-water problem areas. Bacteria contamination was low in all sampling areas. Lead, cadmium and chromium were far below drinking water stand-ards in all but a few wells. (Murphy-IVI) W84-03077

HYDROLOGIC DELINEATION OF NON-POINT SOURCE CONTRIBUTING AREAS,

Science and Education Administration, University Park, PA. Northeast Watershed Research Center. W. J. Gburek.

Journal of Environmental Engineering, Vol. 109, No. 5, p 1035-1048, October, 1983. 7 Fig, 19 Ref.

Descriptors: \*Hydrologic delineation, \*Nonpoint pollution sources, Land use, Regulations, Rainfall-runoff relationships, Surface flow, Surface runoff, Hydrodynamics, Simulation analysis.

Land-use regulations for reduction of nonpoint source pollution from surface-applied contaminants do not usually consider the differing hydrologic responses of land areas based on soil type, slope, proximity to the stream, and expected rainfall. To help overcome this shortcoming, one can define the area of a watershed contributing surface runoff directly to the stream as the result of any rain. Using design rainfalls and initial watershed soil moisture as input, a man can be drawn showing the moisture as input, a map can be drawn showing the return period with which any part of the water-shed contributes surface runoff, and thereby potential nonpoint source pollution, to the stream. A small agricultural watershed in east-central Pennsylvania defines the restricted-use areas on a water-shed and eliminates the subjective nature of commonly proposed land-use regulations by accounting for both the watershed characteristics and the probabilities controlling the generation of surface runoff and its direct affects on the stream. (Murphy-IVI) W84-03086

GRAVITY WASTEWATER COLLECTION SYS-TEMS OPTIMIZATION, Indian Inst. of Tech., Bombay. A. Gupta, S. L. Mehndiratta, and P. Khanna. Journal of Environmental Engineering, Vol. 109, No. 5, p 1195-1209, October, 1983. 7 Fig, 6 Tab, 22 Ref.

Descriptors: \*Gravity flow, \*Wastewater collec-tion, \*Systems analysis, \*Optimum development plans, Algorithms, Computer models, Dynamic programming, Computers, Cost allocation, Cost analysis, Drainage systems, Drainage patterns, Wastewater management, Water quality control.

It is the obligation of wastewater engineers to use optimal design methodology in present times of high cost of wastewater collection system and limited financial resources to meet the commitment of the Government with respect to urban sanitation. of the Government with respect to urban sanitation. A computer algorithm selects the optimal
depth-diameter combinations for all links of a complete gravity wastewater collection system using
dynamic programming. The algorithm incorporates two subprocesses PI and P2. The subprocesses PI generates all feasible designs of inflowing
lines at a junction manhole whereas P2 uses these
feasible designs to provide the upstream invert
level of the outflow line, simultaneously solving
the matching problem encountered at each junction manhole. The problem of dimensionality is
minimized by exploiting the characteristic features
of wastewater collection system. The optimal
design for a 10.7 km long collection system at
Indian Institute of Technology, Bombay with 52
junction manholes is compared with conventional
design to bring out that the algorithm requires a
small computer memory, a small execution time
cel leads to extinue design for conventer exactive. small computer memory, a small execution time and leads to optimal solution of a complete gravity wastewater collection system. (Murphy-IVI)

CALIBRATION OF NPS MODEL LOADING

FACTORS,
Camp, Dresser and McKee, Inc., Annandale, VA.
J. P. Hartigan, T. F. Quasebarth, and E.

Southerland.

Journal of Environmental Engineering, Vol. 109, No. 6, p 1259-1272, December, 1983. 8 Fig, 5 Tab, 8 Ref.

Descriptors: \*Calibrations, \*Nonpoint pollution submodel, \*Load distribution, Computer models, Nonpoint pollution sources, Pollution load, Land use, Simulation analysis.

The use of continuous simulation models can facilitate the development of loading factors and load-ing projections because they deterministically acount for the impact of hydrometeorologic and physiographic differences on nonpoint pollution loadings. NPS continuous simulation model cali-brated to 11 single-land use watersheds in Chesapeake Bay drainage area derived nonpoint pollu-tion loading factors (total N and total P) for rural, agricultural, and urban land use categories. Flow, rainfall, and nonpoint pollution monitoring records raintail, and nonpoint pollution monitoring records for each test watershed cover approximately 1-1.5 years. Parameter adjustments for calibration of both the hydrologic and nonpoint pollution submodels relied upon NPS model executions with continuous 15-minute rainfall record covering the tinuous 15-minute rainfall record covering the entire monitoring period. Parametric and nonparametric statistics were used to assess goodness-of-fit for nonpoint pollution loading calibration. In light of the higher power than normal statistics for datasets characterized by small sample sizes and skewed distributions, nonparametric statistics are recommended for goodness-of-fit assessments for nonpoint pollution loading models. Each test watershed site of calibrated NPS loading factors for total N and total P covered forest, pasture, high tersned site of cambrated NPS loading factors for total N and total P covered forest, pasture, high tillage cropland, low tillage cropland and urban residential land use categories. Simulated annual unit area loads for each land use are compared for years of normal and above-average rainfall.
(Murphy-IVI)
W84-03093

RESERVOIR CIRCULATION PATTERNS AND WATER QUALITY,
Georgia Inst. of Tech., Atlanta. School of Civil

Engineering.
For primary bibliographic entry see Field 2H.
W84-03094

DIFFUSIVITY-BASED FLUX OF PHOSPHO-

RUS IN ONONDAGA LAKE, Upstate Freshwater Inst., Syracuse, NY. M. C. Wodka, S. W. Effler, C. T. Driscoll, S. D. Field, and S. P. Devan. Journal of Environmental Engineering, Vol. 109, No. 6, p 1403-1415, December, 1983. 5 Fig, 1 Tab, Descriptors: \*Diffusion coefficient, \*Fluctuations, \*Phosphorus, \*Onondaga Lake, Thermal stratification, Organic matter, Organic load, Isotherms, Water pollution effects.

High concentrations of critical phytoplankton nu-trients commonly develop in the hypolimnia of productive lakes as a result of mineralization proc-esses on organic matter depositing from the upper productive waters. The upward transport of phos-phorus through the lower portion of the metalimnion of hypereutrophic Onondaga Lake, is mediated by vertical diffusivity. This upward flux is simulated by Fickian diffusion, which incorporates estimates of the vertical diffusivity coefficient for estimates of the vertical dirusvity coefficient for heat and measurements of the vertical phosphorus gradient. The turbulent component of vertical diffusivity demonstrated a strong seasonality during the stratification period, varying from 0.060 sq cm/sec in early summer to 0.002 sq cm/sec during the maximum stability period of late summer. The total maximum stability period of late summer. The total dissolved phosphorus gradient increased during stratification to a maximum of 0.14 mg/L/m in late August and early September. The internal loading of phosphorus to the epilimnion from diffusivity-based transport during the study is approximately 21% and 18%, respectively, of the external loading of dissolved and total phosphorus. The elimination of the present industrial ionic loading to the lake could result in increased internal loading of phosphorus through vertical transport by as much as a factor of 7. (Murphy-IVI) W84-03097

ACCUMULATION OF PCBS, MERCURY AND CADMIUM BY NEREIS VIRENS, MERCEN-ARIA MERCENARIA AND PALAEMONETES PUGIO FROM CONTAMINATED HARBOR SEDIMENTS.

Environmental Research Lab., Gulf Breeze, FL. N. I. Rubinstein, E. Lores, and N. R. Gregory. Aquatic Toxicology, Vol. 3, No. 3, p 249-260, April, 1983. 4 Fig, 1 Tab, 23 Ref.

Descriptors: \*Bioaccumulation, \*Polychlorinated biphenyls, \*Mercury, \*Cadmium, \*Sandworms, \*Clams, \*Shrimp, \*Contamination, \*Sediments, Descriptors: "Biosecumulation, Forgeninal and biphenyls, "Mercury, "Cadmium, "Sandworms, "Clams, "Shrimp, "Contamination, "Sediments, Dredging, Ocean dumping, Fate of pollutants, Bioindicators, Coastal zone management, Water quality management, Water pollution control.

To ensure that disposal operations are conducted with a minimal degree of risk, dredged material destined for ocean disposal must be evaluated on the basis of criteria established by the Environmental Protection Agency. Disposal evaluations cur-rently utilize bioassays to determine the biological availability of contaminants associated with dredged sediments. In a 100-day period in New York Harbor sandworms (Nereis virens), hard clams (Mercenaria mercenaria) and grass shrimp clams (Mercenaria mercenaria) and grass shrimp (Palaemonetes pugo) had an accumulation of polychlorinated biphenyls (PCBs), mercury, and cadmium. Of the three contaminants monitored, only PCBs were found to bioaccumulate above background (control) concentrations. Small increases in PCB body burden were in M. mercenaria and P. pugio, whereas higher concentrations were in N. virens. Uptake was affected by the organic content of the sediment. Bioaccumulation factors (concentration in tissue/concentration in sediment) for N. virens ranged from 1.59 in a low organic sediment. tration in tissue/concentration in sediment) for N. virens ranged from 1.59 in a low organic sediment to 0.15 in a high organic sediment. Sediment concentration alone does not reflect bioavailability and toxicity tests (bioassays) and field monitoring remain the most direct method for estimating bioaccumulation potential of sediment-bound contaminants. (Murphy-IVI)

PCB DYNAMICS IN HUDSON RIVER STRIPED BASS, II. ACCUMULATION FROM DIETARY SOURCES,

New York Univ. Medical Center, NY. Inst. of Environmental Medicine.

J. C. Pizza, and J. M. O'Connor. Aquatic Toxicology, Vol. 3, No. 4, p 313-327, May, 1983. 5 Fig, 3 Tab, 32 Ref. NIEHS grant ES

#### Field 5-WATER QUALITY MANAGEMENT AND PROTECTION

### Group 5B-Sources Of Pollution

Descriptors: \*Polychlorinated biphenyls, \*Fish, \*Fate of pollutants, Hudson River, Bass, Pharmacokinetics, Organic compounds, Industrial wastes, Water pollution effects, Bioaccumulation.

The entire food web of the Hudson esturary is contaminated with PCB. It may be assumed, therefore that PCB accumulation by fish is due partly to direct uptake from water and partly due to accumulation from the diet. Young-of-year striped bass given known doses of (14)C-labeled Aroclor 1254 in natural food by gavage had polychlorinated biphenyl accumulation from the gut. Elimination from the whole body were determined empirically for single-dose and multiple-dose studies. The data have been applied to models describing adsorption site kinetics and fluctuations in whole body burden at steady state. Those variables critical to the calculation and understanding of bioaccumulation fac-tors, namely growth, metabolic rate, and dose, are discussed in the context of the kinetic model results. (Baker-IVI) W84-03113

COPROSTANOL DISTRIBUTION FROM SEWAGE DISCHARGE INTO SARASOTA BAY,

FLORIDA,
Mote Marine Lab., Sarasota, FL.
R. H. Pierce, and R. C. Brown.
Bulletin of Environmental Contamination and
Toxicology, Vol. 32, No. 1, p 75-79, January, 1984.
1 Fig. 15 Ref.

\*Pollutant Descriptors: \*Wastewater treatment, Coprostanol, Feces, Sarasota Bay, Florida, Wastewater, Sewage bacteria, Fate of pollutants

Distribution of the fecal sterol, coprostanol, in acdiment from 41 sites throughout Sarasota Bay, Florida, determined the impact of sewage effluent discharged from the City of Sarasota's wastewater treatment plant. Coprostanol was used as the indicator to estimate the extent to which sewage-derived particulate matter has been distributed within Sarasota Bay sediment. To estimate the area of the bay impacted by the sewage effluent it is of the bay impacted by the sewage effluent, it is assumed that a coprostanol concentration of more than 10 ng/g dry-weight sediment indicates the presence of sewage derived material. The area affected by corprostanol was about 36 sq km. To observe corprostanol input from non-sewage efflu-ent sources, sediment was taken from the mouth of two tributary draining areas of land-use similar to Whitaker Bayou. These sites were Bowless Creek and Hudson Bayou. The relatively high coprosta-nol concentration found in Hudson Bayou may be related to sewage due to periodic overflow that has been documented from sewer lines in that area. has been doe (Baker-IVI) W84-031W

THE GEOCHEMISTRY OF IRON AND MAN-GANESE IN THE WATERS AND SEDIMENTS OF BOLSTADFJORD, S. W. NORWAY, Lancaster Univ., Bailrigg (England). Dept. of Environmental Sciences. For primary bibliographic entry see Field 2K.

CARBON DIOXIDE EMISSION AND CARBON ACCUMULATION IN COASTAL WETLANDS, na State Univ., Baton Rouge. Center for

C. J. Smith, R. D. DeLaune, and W. H. Patrick, Jr. Estuarine, Coastal and Shelf Science, Vol. 17, No. 1, p 21-29, July, 1983. 4 Fig. 3 Tab. 28 Ref.

Descriptors: \*Carbon dioxide, \*Emission, \*Accumulation, \*Coastal marshes, Fluctuations, Carbon cycle, Marshes, Detritus, Accretion, Organic carbon, Chemical properties, Barataria basin, Lou-

Carbon dioxide production and subsequent release to the atmosphere are important processes in the overall carbon budget in coastal wetlands. Direct measurements of CO2 fluxes from salt, brackish and freshwater marshes in Barataria Basin, Louisiana, had accumulations of 418, 180 and 618 g C/sq

m respectively. Water bodies adjacent to the marsh evolved 103, 54 and 242 g CO2-C/sq m/yr to the atmosphere from saline, brackish and freshwater lakes, respectively. The marshes are a major carbon sink because of the carbon content of the sediment, vertical accretion rates and the bulk density of the sediment. Net carbon accumulation was essentially the same in all three marshes; 183, 296 essentiatly the same in all uriree mainses; 185, 289 and 224 g C/sq m/yr from the salt, brackish and fresh marsh, respectively. there is a limited net export of carbon from these coastal marshes. A large percentage of fixed carbon remained on the marsh, being immobolized in accretionary processes or lost to the atmosphere as CO2. (Murphy-IVI) W84-03136

TRACE METALS IN THE GOTA RIVER ESTU-

Chalmers Univ. of Technology, Goeteborg (Sweden). Dept. of Analytical and Marine Chemis-

L. G. Danielsson, B. Magnusson, S. Westerlund, and K. Zhang.
Estuarine, Coastal and Shelf Science, Vol. 17, No. 1, p 73-85, July, 1983. 9 Fig, 1 Tab, 17 Ref.

Descriptors: \*Trace metals, \*Gota River, \*Estuaries, Sediment transport, Sediment distribution, Particulate matter, Path of pollutants, Mixing, Cadmium, Copper, Iron, Nickel, Lead, Zinc,

The Gota River and its estuary are relatively unpolluted compared to other similar areas. The estuary represents a salt wedge type estuary and is situated in a densely populated region of Sweden. The concentrations of trace metals Cd, Cu, Fe, Ni, Pb and Zn are in the range regarded as background levels for freshwater. Metal fractions include acid, leachable diseased well shill and persistence. ground levels for treshwater. Metal tractions in-clude acid-leachable, dissolved, labile and particu-late. When water with low suspended matter con-centration reaches the estuary conservative behav-ior of the trace metals generally occurs, the main for of the trace metals generally occurs, the main exceptions being dissolved iron and lead. These are the only elements that partly exist in colloidal form in the Gota River estuary. The processes of remov-al of dissolved trace metals is not very effective. The conservative behavior of several trace metals may be due to the low dissolved iron concentra-tion. Although iron is partly removed the amount of new iron-rich particles formed in the estuary is too small to influence the dissolved concentration of the other trace metals, save lead. (Murphy-IVI)

QUALITY CHANGES IN BAGHDAD CANALS AND IRRIGATION,

Biological Research Center, Baghdad (Iraq). Dept. of Pollution Research. M. F. Al-Shahwani, M. W. Ishaq, A. K. Al-Hindawi, S. A. Ali, and N. Muthafar.

Journal of Environmental Sciences and Health, Vol. A18, No. 6, p 773-785, 1983. 2 Fig. 2 Tab, 7

Descriptors: \*Baghdad, \*Iraq, \*Canals, \*Water quality, Irrigation canals, Domestic wastes, Coliforms, Diatoms, Water pollution sources, Heavy etals, Saline water

The change of physical, chemical and biological characteristics of Al-Jaysh and Al-Khair canals are due to continuous untreated discharge of domestic waste. Al-Jaysh contained higher turbidity and electrical conductivity than Al-Khair. Both parameters decreased from up to down stream. Fecal eters decreased from up to down stream. Fecal coliform and diatom amounts in both canals were about the same. Diatoms decreased from up to down stream and had a higher resistance than fecal coliform at Al-Khair. Al-Khair contained higher biological oxygen demand than Al-Jaysh. There was no sign of self purification for both canals. In general, heavy metals decreased from up to down stream. Sedimentation of these metals, rather than precipitation, was more important. In most of the agriculture area in Baghdad, a build up of salt due to excessive irrigation and the absence of drainage can amount to 12.7 t/ha/year from Al-Jaysh, and 11.5 t/ha/year from Al-Khair. (Murphy-IVI)

PCB AND DDT CONCENTRATIONS OF SEDI-MENTS FROM SWISS SHORELINE OF LAKE GENEVA, SWITZERLAND, (CONCENTRA-TIONS EN PCB ET DDT DES SEDIMENTS SUPERFICIELS DE LA RIVE SUISSEC DU LAC LEMAN),

Ecole Polytechnique Federale de Lausanne (Switzerland). Inst. du Genie de l'Environnement. P. G. Burgermeister, K. Aswald, L. Machado, J. Mowrer, and J. Tarradellas.

Schweizerische Zeitschrift fur Hydrologie, Vol. 45, No. 1, p 233-245, October, 1983. 4 Fig, 4 Tab,

Descriptors: \*Polychlorinated biphenyls, \*DDT, \*Sediments, \*Lake Geneva, \*Switzerland, Pesticides, Lake shores, Graphical analysis, Pollutant identification, Water pollution.

The concentrations of PCB, p,p'-DDT, p,p'DDD and p,p'-DDE from sediment samples from the shoreline of Lake Geneva were taken at 15 places snoreme of Law Centeva were taken at 15 piaces at depths varying between 10 and 25 m. The PCB concentrations, expressed in dry weight of sediment, varied from 20 micrograms/kg in the region of Les Grangettes to 420-430 micrograms/kg in the of Les Grangettes to 420-430 micrograms/kg in the Lausanne area. These concentrations are high and could produce a long-term contamination of the Lake Geneva ecosystem. The PCB identified consisted mainly of moderately and highly chlorinated biphenyls. The concentration of p.p.'-DDT, p.p.'-DDD and p.p.'-DDE, expressed in dry weight of sediment, varied from 0.5 micrograms/kg in the region of Les Grangettes to 49 micrograms/kg in the Cully area. These types of pollution (especially DDT) are decreasing in the lake ecosystem. DDT) are decreasing (Murphy-IVI) in the lake ecosystem W84-03173

EFFECT OF SOLUBLE SPECIES RELEASED FROM SOIL SOURCES ON THE COMPOSITION OF SOIL AND DRAINAGE SOLUTIONS, Agricultural Research Organization, Bet-Dagan (Israel).

R. Levy, I. Shainberg, R. Mazouz, and H. Eisenberg.

Soil Science Society of America Journal, Vol. 47, No. 6, p 1092-1096, November/December, 1983. 3 Fig, 6 Tab, 14 Ref.

Descriptors: \*Irrigation water, \*Minerals, \*Lea-chates, \*Soil chemistry, Chlorides, Bicarbonates, Sodium, Soil solution, Calcium, Magnesium, Water pollution sources, Dissolution.

Two soils differing in the amounts of calcium and magnesium released during dissolution of soil minerals, cation exchange capacity (CEC), lime content, and water-holding capacity were irrigated under the same conditions with four synthetic waters. Two of the waters contained only chloride, and the other two contained both chloride and bicarbonate anions. Sodium adsorption ratios of the two chloride and two bicarbonate waters were either 10 or 20. Following every 10 wetting and drying cycles the two soils were leached with about 10% excess water. Five such leachates were collected and analyzed. Soil analysis was performed after 20 and 40 irrigation cycles. A significant difference was found between the chemical composition of the drainage and soil solutions of the two soils. To evaluate this diversity, the law of mass conservation was used to calculate the amounts of calcium and magnesium released by dissolution in the absence and presence of carbon dissolution in the absence and presence of carbonate precipitation. Two assumptions were used in these calculations: (i) during irrigation with the chloride waters no precipitation of carbonates occurred, and (ii) during irrigation with the bicarbonate waters no dissolution took place. These assumptions proved valid only for the soil that released small amounts of salt by dissolution. The two soils released almost equal amounts of calcium and magnetium from exchange sites although and magnesium from exchange sites, although there was a significant difference in CEC. It was concluded that the primary source that induced the differences in chemical composition of the drainage and soil solutions was the amount of calcium and magnesium released by mineral dissolution.
(Author's abstract) W84-03180

#### Sources Of Pollution-Group 5B

INVESTIGATIONS ON HEAVY METAL SPECIATION IN NATURAL WATERS BY VOL-CIATION IN NATURAL WATERS BY VOL-TAMMETRIC PROCEDURES, Kernforschungsanlage Juelich G.m.b.H. (Germa-ny, F.R.). Inst. fuer Angewandte Physikalische Chemie.

H. W. Nurnberg. Fresenius Zeitschrift für Analytische Chemie, Vol. 316, No. 6, p 557-565, November, 1983. 6 Fig, 1 Tab, 56 Ref.

Descriptors: \*Heavy metals, \*Chemical speciation, \*Voltammetry, Natural waters, Water pollution, Complexation, Metalloids.

The speciation of dissolved heavy metals is of great significance for their interactions with suspended matter and sediments and their uptake by aquatic organisms. Substance-specificity combined with extraordinary detection sensitivity and inherently high accuracy make suitable advanced modes of polarography and voltammetry one of the most powerful and convenient methodological approaches for speciation studies of heavy metals. powerful and convenient methodological approaches for speciation studies of heavy metals of cotoxic significance in all types of natural water. Not all heavy metals are accessible to voltametry, but voltammetry is one of the most powerful methods for studies of heavy metals and metal-loids of predominant ecotoxic significance and impact. Diagnostic information on the speciation and distribution emerge in the course of the analytical procedure for the determination of the overall heavy metal concentrations in the dissolved state and the suspended matter phase of natural waters. and the suspended matter phase of natural waters. The complexation capacity is conveniently determined by a voltammetric titration. A very impor-tant and successful application area of voltammetry in heavy metal speciation research is specific stud-ies with defined heavy metal complex species on the general physiochemical parameters governing the speciation of the heavy metal in various natural the speciation of the heavy metal in various natural water types. Dissolved heavy metals exist in natuwater types. Dissolved heavy metals exist in natural waters in three categories of species: labile complexes, predominantly formed with inorganic ligands; free hydrated cations; and stable non-labile complexes, predominantly of natural origin but in certain pollution situations also from anthropogenic sources. (Moore-IVI) W84-03185

ON THE COORDINATION BETWEEN METALS AND AQUATIC HUMIC MATERIAL (ZUR KOORDINATIVEN BINDUNG VON ME-TALLIONEN AN GEWASSERHUMINSTOFFE, Technische Univ., Munich (Germany, F.R.). Inst. fuer Wasserchemie und Chemische Balneologie. F. H. Frimmel, and J. Geywitz.

Fresenius Zeitschrift fur Analytische Chemie, Vol. 316, No. 6, p 582-588, November, 1983. 3 Fig, 9 Teb. 31 Feb.

Tab. 31 Ref.

Descriptors: \*Humic substances, \*Metals, \*Chemical binding, Copper, Dissolved organic carbon, Complexation, Heavy metals, Iron, Hydroxamic acid, Photochemical decomposition, Ligands.

Humic substances (HUS) are present in all aquatic systems. Their analytical identification and quantification suffers from a lack of knowledge of the general structure. Therefore sum- and group-parameters, such as dissolved organic carbon (DOC) or carboxylic groups, are of great importance for the characterization of humic substances and their the characterization of humic substances and their reactivity. Humic/metal interactions can be determined under defined reaction conditions. Model experiments are helpful to confirm these results. Complexation capacities (CC) reflect the maximum of metal binding ability for the unit of HUS. The CC in respect to Cu(II) was determined by the titration of the initial amount of Cu(II) (10 micro mol/1) with a HUS-solution of known DOC at a pH-value of 6.8. Differential pulse polarography with a dropping mercury electrode was used for detection. The results (2 to 7 micro mol per mg DOC) suggest complex formation by oxygen con-DOC) suggest complex formation by oxygen containing functional groups in addition to nitrogen containing ones. Iron, strongly bound to HUS even taming tunctional groups in addition to introgen containing ones. Iron, strongly bound to HUS even at pH 2.2, shows some similarities to Fe(III) in hydroxamic acid compounds. Coordination of Hg(II) onto thio-groups of the humics can be confirmed by means of photochemical decomposition reactions using model ligands and natural samples.

CCs for isolated humics suggest that in most natucas for isolated numers suggest that in most natural aquatic systems there is an excess of organic ligand functions compared with the dissolved heavy metals. CCs, however, should only be discussed in close connection with the determination method applied and the reference metal concerned. (Author's abstract)

BONDING FORMS OF HEAVY METALS IN SEDIMENTS AND SLUDGES: SORPTION/MOBILIZATION, CHEMICAL EXTRACTION AND BIOAVAILABILITY (BINDUNGSFORMEN VON SCHWERMETALLEN IN SEDIMENTEN UND SCHLAMMEN: SORPTION/MOBILISTIERUNG, CHEMISCHE EXTRAKTION UND BIOVERFUGBARKEIT),

Technische Univ., Hamburg (Germany, F.R.). Arbeitsbereich Umweltschutztechnik.

Fresenius Zeitschrift fur Analytische Chemie, Vol. 316, No. 6, p 604-611, November, 1983. 7 Fig. 5 Tab, 70 Ref.

Descriptors: \*Heavy metals, \*Chemical binding, \*Sediments, \*Sludge, \*Bioavailability, Extraction, Sorption, Mobilization, Iron, Manganese, Organic matter, Chemical speciation, Aquatic environment.

Only part of the metals present in sediments or sludges are involved in short-term geochemical processes and/or are bioavailable. Hydrous Feprocesses and/or are bioavailable. Hydrous re-and Mn-oxides as well as organic matter, partly as coatings or films on detrital grains, are important substrates for the interactions with dissolved metal species in aquatic systems. For the differentiation of the relative bonding strength of metals on various solid phases and for the estimation of their potential reactivity under variable environmental potential reactivity under variable environmental conditions sequential extraction procedures were used. While these determinations seem to pose basically operational problems, the correlation of the data from solid speciation with the processors and extent of the biological uptake is still unsatisfactory. This is mainly due to the competition between sorption sites on solid matter and biological processes for dissolved metals. Investigations on pore waters could give useful indications on the availability of metals for organisms. (Author's abstract) stract)

EFFECTS OF SURFACE MINING ON AQUATIC RESOURCES IN NORTH AMERICA,

W84-03188

W84-03202

L. B. Starnes Fisheries, Vol. 8, No. 6, p 2-4, November-December, 1983. 5 Ref.

Descriptors: \*Surface mining, \*Environmental effects, \*Hydrologic systems, Aquatic habitats, Land reclamation, Planning, Resources management,

Mining may result in long-term disruption of ter-restrial and aquatic habitats, and hydrologic sys-tems. The magnitude of surface mining impacts on aquatic life depends on the mining technology employed, extent of the disturbance, chemical and employed, extent of the disturbance, chemical and physical composition of the mineral, surface and subsurface hydrologic patterns, and methods of reclamation. Research and monitoring needs asso-ciated with specific minerals or mining techno-ogies include methodology, development, wetland reclamation strategies, stream strategies and methods of predicting eventual toxicity. This encompasses a need for collaborative data bases and regionalized computer models to provide alternative strategies and a priori answers concerning when multiple mines will create unacceptable improved to the provide and the provided provided and the provided provided and the provided pacts. (Murphy-IVI) W84-03197

FLUORIDE POLLUTION IN FRENCH RIVERS AND ESTUARIES.

Ecole Normale Superieure, Paris (France). Lab. de Geologie. For primary bibliographic entry see Field 2L.

AGRANGIAN METEOROLOGY AND MEAS UREMENTS OF ACIDIC PRECIPITATION AT

WASHINGTON, D.C., National Oceanic and Atmospheric Administra-tion, Rockville, MD. Air Resources Labs. R. R. Draxler.

Atmospheric Environment, Vol. 17 No. 12, p 2525-2531, 1983. 6 Fig, 2 Tab, 17 Ref.

Descriptors: \*Lagrangian meteorology, \*Acid rain, \*Washington, \*District of Columbia, Hydrogen ion concentration, Temperature, Rainfall, Humidity, Model studies, Air pollution, Fate of pollution, Sulfur compounds, Nitrogen compounds, Chemistry of precipitation.

Various studies have attempted to link episodes of acidic rainfall with particular source regions with-out considering the intervening chemical and phys-ical processes of Eulerian and Lagrangian models ical processes of Eulerian and Lagrangian models using an emmission inventory coupled with rainfall chemistry-modules to account for sulfate deposition over the region of interest. In the latter, more complex models, it is presumed that the rainwater pH is related to the SO4/NO3 deposition. Lagrangian averages of temperature, rainfall, relative humidity and normalized concentration from a multiple source trajectory model compares with measurements of pH from daily rainwater samples collected around the Washington, DC area during 1975. A linear regression procedure in which pH depends upon the previous four parameters deter-mines the likely source regions during the year. The most consistent acidic rainfall occurred during an extended period from May to June when the flow was from the north. Some investigators have suggested that the rainfall at the receptor is a better predictor of pH than the Lagrangian pre-cipitation. Tests of the four independent variables indicated that the most important predictor of pH districts the surpress of the pH districts the autors most properties. indicated that the most important predictor of pH during the summer was average rainfall along the trajectory (slope > 0). The variability of the meteorological conditions along the pollutant trajectories was able to explain half of the variance of pH, suggesting that at least during summer complex chemical models may not be necessary to simulate acidic precipitation. During the winter, the results were more ambiguous, with the normalized concentration appearing to be the best predictor of pH. (Murphy-IVI) W84-03286

CHEMICAL COMPOSITION OF WATER-BODIES IN THE ENGLISH LAKE DISTRICT: RELATIONSHIPS BETWEEN CHLORIDE AND OTHER MAJOR IONS RELATED TO SOLID GEOLOGY, AND A TENTATIVE BUDGET FOR WINDERMERE,

Freshwater Biological Association, Windermere (England).

For primary bibliographic entry see Field 2K. W84-03293

MICROBIAL HETEROTROPHIC UTILIZA-TION OF DISSOLVED ORGANIC MATTER IN

A PIEDMONT STREAM,
Academy of Natural Sciences of Philadelphia,
Avondale, PA. Stroud Water Research Center.
L. A. Kaplan, and T. L. Blott.
Freshwater Biology, Vol. 13, No. 4, p 363-377,
August, 1983. 6 Fig, 8 Tab, 35 Ref. NSF grant
DES 77-12902.

Descriptors: \*Microbial utilization, \*Dissolved organic matter, \*Piedmont, \*Streams, Streambeds, Sediments, Bacteria, Dissolved organic carbon, Biosynthesis, Stormflow, White Clay Creek, Pennsylvania, Leachate.

Dissolved organic matter (DOM) contributes significantly to the total organic matter budgets of streams and rivers, often dominating the pool of streams and rivers, often unminating tine pool of organic matter in transport. The microbial heterotrophic utilization of (DOM) was determined experimentally in microcosms using stream water and stream-bed sediments from a third order reach of White Clay Creek (Pennsylvania, U.S.A.). Sources of DOM for the experiments included White Clay Creek water at baseflow and stormflow and cold water extracts of jewel weed (Impa-

#### Field 5—WATER QUALITY MANAGEMENT AND PROTECTION

### Group 5B-Sources Of Pollution

tiens capensis L.) and spicebush (Lindea benzoin (L.) Blume). The heterotrophic activity of the sediments was measured as uptake of the following: dissolved organic carbon (DOC), molecular weight fractions within the DOC pool, carbohydeates assimp neids and pentides phenolics. weight fractions within the DOC poor, carbonly drates, amino acids and peptides, phenolics, and dissolved oxygen (DO), all in the overlying water. Concentrations of adenosine triphosphate (ATP), and direct microscopic counts of bacteria were used to estimate bacterial biomass in the surface sediments. The microcosm experiments showed that specific DOC molecular size classes and DOM that specific DOC molecular size classes and DOM functional groups were selectively removed from solution, exposure to one DOM source affected responses to a different DOM source and certain DOM sources were more readily utilized than others. Continued exposure to a DOM source increased microbial heterotrophic activity (a condition which persisted even after removal of the DOM source for several days). Rates of biotic DOC uptake ranged from 3.6 to 242.8 mg C/sq m/h. 8. Indirect estimates of biosynthesis calculated from DOC and DO data ranged from 1.6 at baseflow and 2.6-61.2 at stormflow to as high as 192.6 mg C/sa m/h when the community was repeatedly mg C/sq m/h when the community was repeatedly exposed to enriched DOM sources. The mean generation tin.es of bacteria in sediments, determined from direct microscopy data, ranged from 12.5 to 46.2 h at 15 degrees C. (Murphy-IVI)

RELATIONSHIPS BETWEEN CHLORIDE AND MAJOR CATIONS IN PRECIPITATION AND STREAMWATERS IN THE WINDER-MERE CATCHMENT (ENGLISH LAKE DIS-

Freshwater Biological Association, Windermere

(England).
D. W. Sutcliffe, and T. R. Carrick.
Freshwater Biology, Vol. 13, No. 5, p 415-441,
October, 1983. 16 Fig. 11 Tab, 79 Ref.

Descriptors: \*Chloride, \*Cations, \*Precipitation, \*Windermere catchment, \*Streams, Hydrogen ion concentration, Sodium, Potssium, Calcium, Magnesium, Water pollution sources, Fate of pollutants, Pollution load, Ions, Chemistry of precipitation, England.

4

Before starting to manipulate the concentrations of solutes we need to know their natural range and identify major sources of variation in local streams Variation in stream water concentrations can be directly related to input by precipitation on the Windermere catchment. The distribution of inver-tebrates in hill-streams is related to the chemical tebrates in hill-streams is related to the chemical composition of streamwater, especially with regard to the concentrations of H(+). Low concentrations of other major ions, Na(+), K(+), Cl(-), might also be important limiting elements for some taxa. Relative contributions of inputs were from precipitation, rocks (Borrowdale Volcanics) and soils, sewage, and decing salt used on highways. In bulk precipitation, ratios of Na(+)/Cl(-) (as microequiv/l) ranged from 0.41 to 1.83 over a 2-year period. The overall volume-weighted mean ratio was 0.86, as in seawater, but 2.4% (1975) and 5.7% (1976) of Cl(-) was non-marine in origin. 5.7% (1976) of Cl(-) was non-marine in origin, being balanced by H(+) (in winter), K(+) and Ca(2+) (in summer). In moorland headwater Ca(2+) (in summer). In moorland headwater streams, Ci(+) is largely derived from precipitation; there is a pronounced annual cycle of midwinter high and midsummer low concentrations unrelated to stream discharge. Na(+) and K(+) display simi-lar cycles but Na(+), Ca(2+) and Mg(2+) (and pH) are discharge-related due to leaching from rocks and soils: 10-20% Na(+), 15-17% Mg(2+) and 65-75% Ca(2+) are so-derived whereas K(+) comes from precipitation. Na(+)/CI(-) ratios in streams on proroundle Volcanics alter seasonally comes from precipitation. Na(+)/Cl(-) ratios in streams on Borrowdale Volcanics alter seasonally, with midsummer values > 1.0. Lower values occur in streams on Silurian Slates where some Cl(-) is apparently derived from rocks. Seasonal changes in streamwater concentrations of Cl(-), Na(+) and K(+) are exponentially related to time. Instantaneous rates of change (%/day) are compared in relation to position in the catchment and inputs from anthropogenic sources. Deicing salt has raised (10-100-fold) the concentrations of Na(+) and Cl(-) in streams on mountain passes; the effects persist throughout the year. (Murphy-IVI) W84-03297

MODEL OF PCB IN THE LAKE MICHIGAN LAKE TROUT FOOD CHAIN,
Manhattan Coll., Bronx, NY. Environmental Engineering and Science Program.
R. V. Thomann, and J. P. Connolly.
Environmental Science and Technology, Vol. 18, No. 2, p 65-71, February, 1984. 7 Fig, 1 Tab, 35 Ref. CR 805916010.

Descriptors: \*Fish, \*Water pollution effects, Polychlorinated biphenyls, Organic compounds, Food chains, Model studies.

The significance of the food chain route, i.e., the The significance of the food chain route, i.e., the degree to which a chemical such as PCBs may be accumulated in an organism by predation, needs to be placed in a rechanistic predictive framework to be able to calculate expected levels under field conditions. An age-dependent food chain model that considers species bioenergetics and toxicant exposure through water and food is developed. The model is successfully calibrated to 1971 PCB concentrations of Lake Michigan alewife and lake trout by using a dissolved PCB concentration in the water of 5-10 nanograms/liter. The model indicates that for the top predator lake trout. PCB cates that for the top predator lake trout, PCB exposure through the food chain can account for greater than 99% of the observed concentration. exposure through the roots chain can account or greater than 99% of the observed concentration. An octanol-water partitioning calculation and lake trout lipid concentrations failed to reproduce the observed data by a factor of about It is estimated that a criterion specifying that PCB concentrations of all ages of lake trout be at or below 5 micrograms/g in the edible portion would require that dissolved PCB concentrations be reduced to somewhere between 0.5 and 2.5 ng/liter. The projections of the behavior of the lake trout food chain to reduced water concentrations indicate that followreduced water concentrations indicate that follow-ing reduction in water column PCB concentras, a period of about 5 years is needed to reduce tions, a period of about 5 years is needed to reduce whole body PCB concentration in upper age class lake trout. Younger age classes can generally be exposed to higher water PCB concentrations than older age classes without exceeding the objective of 5 micrograms/g. If water quality projections indicate a lower bound in the achievable PCB water concentrations, a size-dependent fish consumption guideline can be developed. (Baker-IVI) W84-03326

SOURCES AND TRANSPORT OF HYDROCAR-BONS IN THE GREEN-DUWAMISH RIVER,

National Oceanic and Atmospheric Administra-tion, Seattle, WA. Pacific Marine Environmental

Lao. S. E. Hamilton, T. S. Bates, and J. D. Cline. Environmental Science and Technology, Vol. 18, No. 2, p 72-79, February, 1984. 3 Fig, 2 Tab, 33 Ref.

Descriptors: \*Hydrocarbons, \*Water pollution sources, \*Rivers, Green-Duwamish River, Wash-ington, Estuarine environments, Sewage discharge, Wastewater treatment facilities, Wastewater.

Hydrocarbon compounds are introduced into nearshore waters by wastewater discharge, surface runoff, casual spillage, and atmospheric deposition. Since petroleum hydrocarbons are largely hydro-phobic and lipid soluble, a major transport mechaphobic and lipid soluble, a major transport mecha-nism of these compounds in riverine and estuarine systems is via their association with suspended particulates. Five major sources of hydrocarbons have been defined along the Green-Duwamish River. The plant wax hydrocarbons are the pre-dominant compounds in the upper river. Pentadec-ane, heptadecane, and several C-17 monoenes are produced by algae in the river. Highway runoff along the river contributes the suite of C14-C20 alkanes. The terpenoids and high concentrations of alkanes. The terpenoids and high concentrations of pristane appear to be erosional in origin and are periodically transported down the river under high flow conditions. A secondary waste treatment plant is a major point source of hydrocarbons to the river. The differences in hydrocarbon concentrations between test stations can be largely attributed to simple dilution. A disparity was noted when attempts were made to quantitatively account for the input from the Renton Sewage Treatment Plant. This disparity may be due to the flocculation and sedimentation of organic matter es. The terpenoids and high concentrations of

during mixing of the effluent and river water with subsequent near-bottom transport of this material during periods of high river flow. (Baker-IVI) W84-03327

SEWAGE SLUDGE COAGULATION AND SET-

TLING IN SEAWATER, California Univ., Berkeley. Div. of Sanitary, Envi-ronmental, Coastal, and Hydraulic Engineering. J. R. Hunt, and J. D. Pandya.

Environmental Science and Technology, Vol. 18, No. 2, p 119-121, February, 1984. 1 Fig. 2 Tab, 9 Ref.

Descriptors: \*Sludge coagulation, \*Settling, \*Seawater, \*Particulates, Model studies, Coagulation, Mathematical models, Sludge disposal, Fate of pol-

The removal of sewage sludge particles from sea-water is controlled by particle coagulation and the settling of aggregates as they are formed. Anaero-bically dispeted sewage sludge coagulation in arti-ficial seawater at fluid shear rates of 0, 0.25, 0.5, 1, 2, 4, and 8/s with a rotating cylinder apparatus, had a sludge removal rate with a second order in sludge concentration and was dependent on the fluid shear rate. The settling velocity of aggregatzs produced at a given shear rate was constant. Lizaitproduced at a given snear rate was constant. Limited experience to date suggests that particle coagulation rate and aggregate settling velocity are very dependent on fluid and particle properties. For this reason, specific data must be obtained for each waste under consideration. (Murphy-IVI) W84-03328

AFFINITY OF HYDROPHOBIC POLLUTANTS FOR NATURAL ESTUARINE COLLOIDS IN AQUATIC ENVIRONMENTS,

Maryland Univ., Solomons, Chesapeake Biological

R. D. Wijayaratne, and J. C. Means. Environmental Science and Technology, Vol. 18, No. 2, p 121-123, February, 1984. 1 Fig, 12 Ref.

Descriptors: \*Herbicides, \*Estuarine environment Aquatic habitats, Water pollution effects, Chemical reactions, Colloids, Chromatography, Oxidation.

Gel chromatographic techniques were used to study the interaction of natural estuarine colloids with a model herbicide, (14)C labeled atrazine. Dissolved organic carbon binds atrazine and holds the resulting aggregate of molecules in stable col-loidal suspension. Hydrophobic compounds held in such a manner show behavior characteristic of the natural organic matter rather than the behavior they would normally exhibit in solution. Oxidation of the compound-colloid complex by hydrogen of the compound-colloid complex by hydrogen peroxide or hypochlorite resulted in the partial destruction of the complex and release of bound herbicide. The average molecular weight of the estuarine polymer was estimated to be 10,000. The molecular weight is decreased with oxidation. Recoveries of radiolabeled atrazine from the gel chrocoveries of radiolabeled atrazine from the gel chromatograpy studies in distilled water, estuarine colloids, and colloids treated with NaOCl and H2O2 were 80%, 90%, 84%, and 82%, respectively. Depending on their stability in the colloidal state, hydrophobic contaminants can accumulate in concentrations far in excess of that expected for pure water. As surface-active organic matter is ubiquitous in natural waters, it seems reasonable to conclude that colloids may play a significant role in ties of hydrophobic contaminants in aquatic systems, which might otherwise be sequestered in sediments. (Baker-IV1)
W84-03329 the distribution and concentration of trace quanti-

PROCESSES CONTROLLING METAL ION ATTENUATION IN ACID MINE DRAINAGE

Commonwealth Scientific and Industrial Research Organization, Ryde (Australia). Physical Technol-

ogy Unit.

B. M. Chapman, D. R. Jones, and R. F. Jung.

#### WATER QUALITY MANAGEMENT AND PROTECTION—Field 5

#### Sources Of Pollution—Group 5B

Geochimica et Cosmochimica Acta, Vol. 47, No. 11, p 1957-1973, November, 1983. 10 Fig, 5 Tab, 51 Ref.

Descriptors: \*Acid mine drainage, \*Metals, Heavy metals, Iron, Potassium, Lead, Copper, Zinc, Cad-miun, Sediments, Water analysis, Streams, Mine drainage, Water pollution source.

The study of the distribution of heavy metals at trace levels in uncontaminated natural streams provides information about the mechanisms which control the mobility of these elements at low con-centrations. Detailed analyses were made of the sediments and waters in two acid mine drainage sediments and waters in two acid mine drainage streams to understand the dominant processes con-trolling the transport and attenuation of heavy metals under conditions of chronic high-level pol-lutant input. One of the water courses has a thick hydrous iron oxide crust on its bed, where biotical-ly mediated oxidation of ferrous iron resulted in ly mediated oxidation of ferrous iron resulted in precipitation of amorphous ferric hydroxide, along with substantial quantities of adsorbed silica, sulfate and Al and lesser quantities of As. Small amounts of K and Pb jarosites were also present in the sediments. Changes in pH and in the concentrations of Cu, Zn, and Cd appear to be mainly the result of dilution by seeps and tributaries. Although no sediment was recovered during collection of water samples from the second stream, saturation index calculations imply that precipitation was occurring. The basis for a potentially useful new tecnique, congruent element analysis, which enables the identification of conservative components in streams is presented. Comparison of logarithmic concentration versus distance plots delogarithmic concentration versus distance plots de-lineates the point where chemical removal mechanisms become important for each element. (Baker-IVI) W84-03331

TRANSFORMATIONS OF TETRACHLOR-OETHENE AND TRICHLOROETHENE IN MI-CROCOSMS AND GROUNDWATER,

Florida International Univ., Miami. Drinking Water Quality Research Center. F. Parsons, P. R. Wood, and J. DeMarco. Journal of the American Water Works Associa-tion, p 56-59, February, 1984. 3 Tab, 20 Ref.

Descriptors: \*Transformation, \*Tetrachloroethene, \*Trichloroethene, \*Microcosms, \*Groundwater, Chemical reduction, Cis-1,2-dichloroethene, Trans-1,2-dichloroethene, Muck soils, Metal-finishing wastes, Incubation

Cis- and trans-1,2-dichloroethene are found in well water at a site contaminated with trichloroethene from a leaking storage tank, although neither com-pound was used in the vicinity nor was present as an impurity in the trichloroethene in the storage tank. The use of tetrachloroethene and trichloroethene in dry cleaning and metal refinishing plants is widespread. Several chloroethene com-pounds that are found in southern Florida groundwater may have been formed from these solvents via microbial metabolism in the groundwater environment. Depletion of tetrachloroethene and ap-pearance of cis- and trans-1,2-dichloroethene and chloroethene are present following incubation of tetrachloroethene in microcosms containing muck from the aquifer recharge basin. (Murphy-IVI) W84-03367

RADIOCHEMICAL TECHNIQUES APPLIED TO LABORATORY STUDIES OF WATER LEACHING OF HEAVY METALS FROM COAL FLY ASH,

Commission of the European Communities, Ispra (Italy). Radiochemistry and Nuclear Chemistry Div L. Goetz.

Water Science and Technology, Vol. 15, No. 11, p 25-47, 1983. 33 Fig. 4 Tab, 30 Ref.

Descriptors: \*Radiochemical analysis, \*Laboratory studies, \*Leaching, \*Heavy metals, \*Coal, \*Fly ash, Radioactivity techniques, Radioisotopes, Path of pollutants, Radioactive tracers, Isotopic tracers,

Assessment of the potential environmental impact of heavy metals (HM) mobilized by coal-fired power plants showed that water leaching of HM from pulverized fuel ash may for certain HM constitute an important pathway to the aquatic envi-ronment. Batch experiments simulate ash pond ronment. Batch experiments simulate ash pond conditions, whereas column experiments represent water leaching from fly ash deposits. Using radioactive tracers and neutron activation of fly ash the fate of a single HM is easily followed even in very low concentrations. Employing radioisotopic tracers the distribution coefficients of simple ionic forms of As, Sb, Bi, Se, Te, Cr, Mo, W, Ni, and Cd forms of As, 50, Bi, Se, 1e, Cr, Moi, W, Ni, and Co in a coal fly ash/water system is determined as a function of pH. The adsorption and desorption behaviour of HM on coal fly is explained in part on the basis of the surface predominance and the aqueous chemistry of single ionic, mainly anionic, forms of the relative elements. Ion exchange and corns of the relative elements, for exchange and coprecipitation phenomena are also important processes. The nature and concentration of ions contained originally in the water used (distilled water, fly ash leachate and seawater) has a strong influence on the sorptive behavior of HM on coal ashes. (Murphy-IVI) W84-03374

MODEL OF ION EQUILIBRIUM IN AQUEOUS SOLUTIONS OF FLY ASH IN THE CONTEXT OF PREDICTION OF GROUND AND SURFACE WATER CONTAMINATION,
Instytut Ksztaltowania Srodowiska, Katowice

Instytut Ksztaltowania Srodowiska, Katowice (Poland). Environmental Pollution Abatement

Centre. M. J. Laczny, E. Krop, and M. Polak. Water Science and Technology, Vol. 15, No. 11, p 239-246, 1983. 3 Fig, 7 Ref.

Descriptors: \*Groundwater contamination, \*Water pollution sources, Predicting, Fly ash, Model studies, Waste disposal, Computers, Algorithms.

Fly ashes contain readily and poorly soluble com-pounds which are leached due to water impact and infiltrate into the environment. Considerations of the impact of power waste landfill on the environment of groundwater and surface waters must not only include the quantitative composition of the aqueous solutions, which are in contact with fly ash, but also the kinetic relationships. Based on lab studies conducted on samples taken from the entire cross section of the disposal site, compounds were closs section of the disposa size, compounds were selected for which a qualitative-quantitative equil-brium model was calculated using electronic com-puters. The algorithm and equations used in the calculations are presented. The algorithm adopted for the calculation is universal for this type of ion equilbria. New equilibria can be easily introduced to the calculation is universal for this type of ion equilibria. New equilibria can be easily introduced to the algorithm. The proposed model permits calculation of the resultant hydrochemical compo-sition of water after mixing of the infiltration water from a landfill site with groundwater or surface waters, provided that the quantity of mixed waters is known. (Baker-IVI)

CHEMICAL PATHWAYS FROM STACK EMIS-

SIONS TO SURFACE WATER,
Central Electricity Generating Board, Leather-head (England). Central Electricity Research

A. S. Kallend. Water Science and Technology, Vol. 15, No. 12, p 9-21, 1983. 4 Fig, 4 Tab, 26 Ref.

Descriptors: \*Fate of pollutants, \*Chemical reactions, Water pollution sources, Air pollution, Sulfur dioxide, Nitrogen oxides, Precipitation.

A complex chain of processes links the production of an anthropogenic atmospheric emission with its action in the aqueous environment. The importance of chemical transformations was examined in determining the impact of atmospheric emissions on the aquatic environment through precipitation. Special attention was given to chemical kinetics. Direct measurements as well as modelling studies based on kinetic parameters determined in the lab have resulted in a reasonable understanding of the gas phase chemical transformation of major pri-mary pollutants. The relative abundance of sulfate

and nitrate in precipitation does not, however, and nitrate in precipitation does not, however, reflect the measured or predicted rate of production of nitric acid and sulfate aerosol in typical plumes in which gas phase chemistry predominates and suggests that, on the average at least, in-cloud chemical transformation along with direct precipitation acavenging accounts for a substantial part of the sulfate actually observed in precipitation at most sites. The chemical interaction of pollutants from the same source and from different sources is brought out most clearly when considering the from the same source and from different sources is brought out most clearly when considering the effect of ambient air composition on the gas phase chemistry in plumes. However, oxidant availability during in-cloud oxidation of sulfur dioxide may be of even greater importance and may sometimes be the rate determining factor for sulfate production. The chemistry of the ambient air is also important at long range, particularly when it is of urban origin because this air itself contains many of the principal components that are also present in power plant plumes including sulfur dioxide, nitrogen oxides and their derivatives. To be both soundly based and cost-effective any future control strategy must likewise rely on a thorough understanding of the chemical pathways linking source and effect and on the resolution to further research of the areas of uncertainty. (Baker-IVI)

TRANSPORT OF AIRBORNE MERCURY EMITTED BY COAL BURNING INTO AQUAT-IC SYSTEMS.

Swedish Water and Air Pollution Research Lab., Goeteborg. C. Brosset.

Water Science and Technology, Vol. 15, No. 12, p 59-66, 1983. 2 Fig, 6 Tab, 6 Ref.

Descriptors: \*Mercury, \*Path of pollutants, Coal, Water pollution sources, Air pollution, Precipitation, Coal combustion, Sweden.

Faced with the possibility of increased use of coal for energy production the Swedish government decided some years ago to sponsor a comprehen-sive investigation of all kinds of emissions connect-ed with the combustion of coal and their eventual impact on the environment. One of the problems to be elucidated emphasized the consequences of the emission of mercury. Concentrations of water solu-ble and insoluble mercury compounds in air, pre-cipitation and smoke from coal combustion have been measured. A concentration of total airborne mercury at remote places in southwestern Sweden mercury at remote piaces in southwestern Sweeten was found to amount to 24 ng/cubic m. About 20% of it is probably anthropogenic. As the concentration in this fraction is proportional to the concentration of soot particles it is probably emitted in connection with coal burning. The total airborne mercury includes a water soluble fraction of 10 200°C. artonne mercury includes a water soluble traction of 10-20%. A big part of this last fraction (about 80%) has stability properties indicating organic mercury compounds, possibly methyl mercury salts. The smoke from coal burning seems to have a similar composition. However, its water soluble a similar composition. Towever, its water solution concentration fraction may be near 70%. This fraction can be easily wet or dry deposited into aquatic systems. (Baker-IVI) W84-03386

SULPHUR AND CHLORIDE DEPOSITION AND ECOSYSTEM TRANSPORT IN A STRONGLY ACIDIFIED LAKE WATERSHED, Swedish Water and Air Pollution Research Lab.,

H. Hultberg, P. Grennfelt, and B. Olsso Water Science and Technology, Vol. 15, No. 12, p 81-104, 1983. 11 Fig, 10 Tab, 11 Ref.

Descriptors: \*Sulfur, \*Chloride, \*Deposition, \*Path of pollutants, \*Acidic lakes, Watersheds, Acidic water, Chemical properties, Acid precipitation, Sweden, Ecosystems.

Field monitoring during a two-year period of con-centrations in air, precipitation, streams and lakes, attempts to synthesize deposition and ecosystem transport of sulfur and chloride through a strongly acidified lake watershed on the Swedish west coast. The dry deposition estimate from concentra-

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tion measurements and deposition estimate from concentration measurements and deposition velocities were in good agreement with monitored outflows. The estimated sulfur deposition to areas with coniferous forests was 25-31 kg/ha per year and to lake areas was 19 kg/ha per year. The marine part of the input is about 10%. The estimated retention of sulfur in the total watershed is 8-21%. (Murphy-IVI) W84-03188

THE EFFECTS OF COAL COMBUSTION AND ACIDIFICATION ON THE CADMIUM EXPOSURE OF THE SWEDISH POPULATION, Studsvik Energiteknik A.B., Nykoeping (Sweden).

Studsvik Energiteknik A.B., Nykoeping (Sweuen). L. Ramberg. Water Science and Technology, Vol 15, No. 12, p 105-113, 1983. 3 Fig. 21 Ref.

Descriptors: \*Carlmium, \*Water pollution sources, Path of pollutants, Fertilizers, Industrial wastes, Sweden, Coal, Coal combustion, Burning, Air pollution

A model has been developed and applied for release situations of cadmium which might occur in
Southern and Middle Sweden. The model describes these areas of Sweden as composed of three
compartments: forests, crop land, and lakes. The
cadmium input to this simplified description of the
biosphere comes from atmospheric precipitation,
fertilizers and industrial releases to water as well as
from coal combustion. The model is limited to an
analysis of the large turnovers of cadmium on a
long time scale in a sector of the biosphere and the
mean health effects on the population as a whole.
Cadmium balance and mobility in crop soils controls the cadmium flow to man. The atmospheric
precipitation of cadmium is of dominant importance for controlling future exposures. The use of
phosphorous fertilizers containing Cd may be
harder to mitigate as alternatives are not well
developed. (Baker-IVI)
W84-03389

HISTORICAL CHANGES IN ACID PRECIPI-TATION AND HEAVY METALS DEPOSITION ORIGINATING FROM FOSSIL FUEL COM-BUSTION IN EASTERN NORTH AMERICA AS REVEALED BY LAKE SEDIMENT GEOCHEM-ISTRY,

Institut National de la Recherche Scientifique, Sainte-Foy (Quebec). M. Ouellet, and H. G. Jones.

M. Ouellet, and H. G. Jones.
Water Science and Technology, Vol. 15, No. 12, p 115-130, 1983. 6 Fig, 2 Tab, 53 Ref.

Descriptors: "Acid rain, "Heavy metals, "Deposition, "Fossil fuel, "North America, "Lake sediments, "Geochemistry, Fuels, Tantare Lake, Laflamme Lake, Air pollution, Mercury, Lead, Zinc, Water pollution sources.

The sediments of remote 'undisturbed' lakes more accurately reflect any changes in atmospheric fall-out from air masses originating from outside the watershed. The geochemical stratigraphic evolution of two soft water lakes (Tantare and Laflarame) reveal that the allochthonous inputs will dominate any changes in total inputs. The increase in Al in the sediments of Lake Tantare since about 1950 is attributed to the processes of surface water acidification of this watershed induced by acid precipitation. The analogous upper strata of the sediments from Lake Laflamme, a non-acidified lake, show no such increase in Al content. Pb, Zn and Hg levels in the sediments increased significantly from 1940 onwards. The subsequent reduction in the stratigraphic concentration of Zn since 1960 in both Lake Tantare and Lake Laflamme is, in all probability, the result of the important decrease of the total particulate emissions to the atmosphere from coal-fired plants. The same phenomenon may also explain Hg decrease during the same period. In contrast, Pb shows no such reduction in the more recent strata and the sustained increase of this element in the sediments is attributed to the progression in motor vehicle activity during the past twenty years. Further data from other isolated lakes suggest that the major sources of heavy metal deposition and acid precipitation in

the Province of Quebec are the emissions from fossil fuel combustion (coal and/or motor fuel) originating in the heavily industrialized American Midwest and Great Lakes Regions. (Murphy-IVI) W84-03390

MINE DRAINAGE AND ROCK TYPE INFLU-ENCES ON EASTERN OHIO STREAM WATER QUALITY,

Geological Survey, Reston, VA. D. R. Helsel.

Water Resources Bulletin, Vol. 19, No. 6, p 881-887, December, 1983. 2 Fig, 3 Tab, 15 Ref.

Descriptors: \*Acid mine drainage, \*Rock properties, \*Ohio, \*Streams, \*Water pollution sources, Geochemistry, Land reclamation, Base flow, Land use, Groundwater pollution.

Stream water during fair weather (base flow) is largely ground water discharge, which has been in contact with minerals of the underlying aquifer. Base flow water quality should therefore reflect aquifer mineralogy as well as upstream land use. Three upstream mining categories (unmined lands, abandoned coal mines, and reclaimed coal mines) differed in pH, specific conductance, sulfate, iron, aluminum, and alkalinity for 122 streams in eastern Ohio. Aquifer rock type influenced pH, specific conductance, sulfate, iron, aluminum, and alkalinity for late streams in eastern ohio. Aquifer rock type influenced pH, specific conductance, sulfate, iron, and alkalinity. Reclamation returned many components of acid mine drainage to near unmined levels, although sulfate and specific conductance were not improved. Acid mine drainage problems were less severe in watersheds underlain by the calcareous Monongahela Formation. These results should apply to other Appalachian coal regions having similar rock units. The water quality data distributions were neither consistently normal nor lognormal. Statistical tests utilizing ranks of the water quality data, instead of the data themselves, provided useful in analyzing the influences of mining category and rock type. (Author's abstract)

LOADING FUNCTIONS FOR PREDICTING NUTRIENT LOSSES FROM COMPLEX WATERSHEDS.

Clemson Univ., SC. Dept. of Agricultural Economics and Rural Sociology.
L. L. D. Delwiche, and D. A. Haith.
Water Resources Bulletin, Vol. 19, No. 6, p 951-959, December, 1983. 1 Fig. 8 Tab, 27 Ref.

Descriptors: \*Water pollution sources, \*Nonpoint pollution sources, \*Nutrients, \*Watersheds, Mathematical models, Load function, Croplands, Forests, Urban areas, Animal wastes, Effluents, Groundwater discharge, West Branch Delaware River, New York.

A loading function methodology is presented for predicting runoff, sediment, and nutrient losses from complex watersheds. Separate models are defined for cropland, forest, urban and barnyard sources, and procedures for estimating baseflow nutrients are provided. The loading functions are designed for use as a preliminary screening tool to isolate the major contributors in a watershed. Input data sources are readily available and the functions on the require costly calibrations. Data requirements include watershed land use and soil information, daily precipitation and temperature records and rainfall erosivities. Comparison of predicted and measured water, sediment, and nutrient runoff fluxes for the West Branch Delaware River in New York, indicated that runoff was underpredicted by about 14% while dissolved nutrients were within 30% of observed values. Sediment and solid-phase nutrients were overpredicted by about 50%. An annual nutrient budget for the West Branch Delaware River showed that cornland was the major source of sediment, solid-phase nutrients, and total phosphorus. Waste water treatment lants and ground water discharge contributed the most dissolved phosphorus and dissolved nitrogen, respectively. (Author's abstract)

THROUGHFALL PH: EFFECT OF PRECIPITATION TIMING AND AMOUNT,

Commonwealth Scientific and Industrial Research Organization, Canberra (Australia). Div. of Water and Land Resources. I. D. Moore.

Water Resources Bulletin, Vol. 19, No. 6, p 961-965, December, 1983. 3 Fig, 23 Ref.

Descriptors: \*Hydrogen ion concentration, \*Precipitation, \*Throughfall, \*Acid rain, Buffering, Deciduous forests, Canopy, Dryfall, Leaves, Kentucky.

Precipitation, throughfall, and stream pH were measured weekly over a 27-week period in 1982 on the Little Millseat watershed in eastern Kentucky. The average pH values over the study period were 4.3, 4.9, and 6.4, respectively, indicating significant buffering as water moved from the atmosphere, through the deciduous canopy, and through or over the soil to the stream. Regression analysis demonstrated that the timing and amount of precipitation were important factors influencing the pH of the throughfall. Weekly precipitation and the three-week average precipitation were statistically significant variables, explaining 53% of the variance in the observed throughfall pH. Precipitation pH was not a statistically significant variable for this watershed and sampling period. During dry periods with little precipitation, the deciduous canopy had a high buffering capacity and throughfall pH remains high (about 6.0) even though the precipitation pH is low. As the frequency, duration and amount of precipitation in the leaf surfaces, and the leaching rates of plant chemicals from the leaves are exceeded by the supply rate of acidic precipitation. At this time a large volume of acidic precipitation is input to the system with little buffering capacity by the canopy, so the throughfall pH decreases rapidly, approaching that of the incident precipitation. After major precipitation events it takes some time for the canopy to recover and for nutrients and plant chemicals to be replaced in the leaves, and for dryfall to build up on leaf surfaces before throughfall pH begins to increase. This time delay varied from about one to three weeks, depending on the amount of precipitation during this recovery period. (Moore-IVI) W84-03401

RELATIONSHIP OF NITRATE CONCENTRA-TIONS TO DISTANCE OF WELL SCREEN OPENINGS BELOW CASING WATER LEVELS, Geological Survey, Lawrence, KS. Water Resources Div.

For primary bibliographic entry see Field 5F. W84-03403

USE OF GEOSTATISTICS TO EVALUATE WATER QUALITY CHANGES DUE TO COAL MINING,

Science and Education Administration, University Park, PA. Northeast Watershed Research Center. A. S. Rogowski.

Water Resources Bulletin, Vol. 19, No. 6, p 983-992, December, 1983. 8 Fig, 2 Tab, 6 Ref.

Descriptors: \*Water quality, \*Coal mining, Groundwater pollution, Variogram, Geostatistics, Environmental effects.

Large variability of water quality data often makes it difficult to judge whether or not the conditions in an aquifer or a stream are deteriorating or improving. A technique for separation of variograms into positive and negative difference components is proposed. This technique was applied to water quality data from a reclaimed site that had been used for coal mining. Distribution of ground water elevations in time at the experimental site showed that highest water levels on both the stripmined and deepmined areas generally follow the occurrence of major storms, while lowest levels appeared to result from 60-day or longer dry spells with rains less than 25 mm. Despite much scatter and variability in the data, sulfate concentrations were most highly correlated with other variables and could be used to estimate each of the other chemical parameters for selected sampling sites.

#### Sources Of Pollution-Group 5B

Therefore, sulfate concentrations were used to illustrate the novel technique designed to show if the water quality was improving or deteriorating. quality improved on the stripmined and undis-turbed area, remained about the same in the deep-mined area, and declined in the seep and stream.

(Baker-IVI) The results show ed conclusively that overall wat

ACID SNOWPACK CHEMISTRY IN PENNSYL-VANIA, 1979-81, Pennsylvania State Univ., University Park. School of Forest Resources. D. R. DeWalle, W. E. Sharpe, J. A. Izbicki, and D. L. Wirries.

Water Resources Bulletin, Vol. 19, No. 6, p 993-1001, December, 1983. 8 Fig. 5 Tab, 16 Ref.

Descriptors: \*Snowpack, \*Acid precipitation, \*Pennsylvania, \*Hydrogen ion concentration, Nitric acid, Sulfates, Sulfur dioxide, Dust, Limestone, Dolomite, Quarries, Water pollution

Snowpack chemistry was evaluated with repeated surveys at 30 sampling sites across Pennsylvania during 1979-81. The mean snowpack pH of 4.25 of 280 samples was largely due to H(+) from nitric acid. Snowpack sulfates were high, especially in the southwest sector of the state, where SO2 emissions were also high. Rain-on-snow and coastal storm snowpacks produced higher snowpack pH. Localized increases in snowpack pH were found due to additions of dust from limestone and dolonite guarry operations, especially in the central mite quarry operations, especially in the central Ridge and Valley Province. Acid loading on the landscape from snow in Pennsylvania is controlled by the total amount of snowfall as well as variations in concentrations of chemical constituents.
(Author's abstract)
W84-03405

EFFECTS OF CLEARCUTTING AND SLASH BURNING ON STREAMWATER CHEMISTRY AND WATERSHED NUTRIENT BUDGETS IN SOUTHWESTERN BRITISH COLUMBIA,

British Columbia Univ., Vancouver. Faculty of

Forestry. M. C. Feller, and J. P. Kimmins. Water Resources Research, Vol. 20, No. 1, p 29-40, January, 1984. 2 Fig, 8 Tab, 63 Ref.

Descriptors: \*Clear-cutting, \*Slash burning, \*Water chemistry, \*Stream pollution, \*British Columbia, Nutrients, Water pollution sources, Sodium, Potassium, Magnesium, Chloride, Phosphorus, Calcium, Nitrates

Two small forested watersheds near Haney in southwestern British Columbia were partially clearcut, and the slash on one of them was subsequently burned. Streamwater chemistry was moni-tored in these treated watersheds and an undisturbed control watershed for 2 years prior to treat-ment and up to 9 years after treatment. The chemical parameters that were studied responded differ-ently to the treatments, but there was a general pattern of increased concentrations and fluxes in streamwater for the first 2-3 years following treatment followed by a decline to, and sometimes below, pretreatment values. The most pronounced increases were observed for K and NO3. It was not possible to determine the exact causes of these changes in concentrations and fluxes, due to the changes in concentrations and fluxes, due to the great variability in the ecosystems present. This variability precluded determination of statistically significant changes in annual terrestrial nutrient fluxes and pools. Stream nutrient exports usually were < 10 kg/ha/yr for each of N, P, K, and Mg, < 20 kg/ha/yr for Na and Cl, and < 30 kg/ha/yr for Ca. These values were considerably less than nutrient exports in harvested logs and in losses to the atmosphere during the slashburn. Clearcutting and burning caused greater nutrient losses than clearcutting alone, particularly in the case of N, where the clearcutting and clearcutting and burning treatments resulted in total losses of 245 kg/ha and 1293 kg/ha, respectively, for the first two and 1293 kg/ha, respectively, for the first years after treatment. (Author's abstract) W84-03410

LAND USE PRESSURES ON COASTAL ESTU-ARIES IN ATLANTIC CANADA, Dalhousie Univ., Halifax (Nova Scotia). Inst. for Resource and Environmental Studies. G. E. Beanlands.

Coastal Zone Management Journal, Vol. 11, No. 1-2, p 117-132, 1983. 2 Fig, 8 Tab, 13 Ref.

Descriptors: \*Estuaries, \*Water pollution sources, \*Land use, \*Nova Scotia, \*New Brunswick, \*Prince Edward Island, Water pollution effects, Shellfish, Aerial photography.

Land-use pressures on estuarine resources were studied in the three Maritime Provinces of Canada (Nova Scotia, New Brunswick, Prince Edward Island). The first phase involved the initial identification of estuaries in the study area through stereoscopic interpretation of recent aerial photographs. The second phase involved the determination of The second phase involved the determination of land and water uses associated with each estuary. Various human activities were identified on the photographs and classified according to 14 major types of developments. This major breakdown was further refined by the addition of sub-categories related to intensity of use, for a total of 22 development types. The only regionally-based and consistent indicator of the biological quality of nearshore waters, including estuaries, is that provided by the shellfish pollution monitoring program of the federal government. As of 1977, over 200 areas in the Maritime Provinces were closed to the harvesting Maritime Provinces were closed to the harvesting of shellfish. The incidence of pollution ranges from 80% of those estuaries supporting industrial activity to 47% of those influenced by recreational cottages. Only 17.7% of development-free estuaries were closed to shellfish harvesting. Forty-two percent of the estuaries supporting one type aries were closed to shellfish harvesting. Forty-two percent of the estuaries supporting one type of use were contaminated compared with 100% contamination of those influence by seven or more types of human activity. Given that 74% of the estuaries in the region have not yet undergone complex and intensive development, every effort should be made to prevent a further deterioration of this valuable resource base before remedial measures are impossible. (Moore-IVI)

OIL AND GREASE IN URBAN STORM-

WATERS, California Univ., Los Angeles. School of Engineering and Applied Science.

M. K. Stenstrom, G. S. Silverman, and T. A

Bursztynsky.

Journal of Environmental Engineering, Vol. 110,
No. 1, p 58-71, February, 1984. 3 Fig, 9 Tab, 30

Descriptors: \*Oil, \*Grease, \*Storm water, \*Water pollution sources, \*Land use, Rainfall, Water pollution control, Simulation, Richmond, California,

A study of oil and grease in urban stormwaters was performed on a small watershed in Richmond, California, with the objective of determining the amount of oil and grease discharged into San Francisco Bay. Five sampling stations were selected at various places in the watershed that were indicative of specific land uses, and runoff from seven storms was samples and analyzed. The results of the survey indicated that oil and grease concentration was highly dependent upon land use, ranging from 4.1 mg/L in residential areas to 15.3 mg/L in parking lots. A statistical analysis of oil and grease parking lots. A statistical analysis of oil and grease and storm characteristics showed that oil and grease concentration was independent of all storm grease concentration was independent of all storm characteristics, except that mass of oil and grease discharged was proportional to total rainfall. Qual-itative analysis of the oil and grease by gas chro-matography indicated that it most resembled used automobile crankcase oil. Several samples showed evidence of spills of specific compounds. A simulaevidence of spins of specific compounds. A simula-tion of management techniques indicated that a 90% reduction in discharge from commercial properties and parking lots, which represented only 9.6% of the total surface area, would result in a 53% reduction in total oil and grease discharge. Growth simulation predicted a potential 27% increase in discharge if 5% of the watershed were converted from open land to commercial property.
(Author's abstract)
W84-03470

#### HISTORY OF PHOSPHORUS LOADING TO ONONDAGA LAKE,

Allied Corp., Jamesville, NY. S. P. Devan, and S. W. Effler.

Journal of Environmental Engineering, Vol. 110, No. 1, p 93-109, February, 1984. 10 Fig. 2 Tab, 45

Descriptors: \*Phosphorus, \*Onondaga Lake, \*New York, Phytoplankton, Nutrients, Fate of pollutants, Lake restoration, Water pollution control, Calcium, Eutrophication, Sediments, Pollution load, Lake Ontario.

The history of phosphorus loading to, and efflux from, Onondaga Lake, New York, is presented for a 12-yr period (1970-1981), during which several phosphorus management measures were taken. A ten-fold reduction in phosphorus loading since 1970 has been achieved through implementation of reclamation measures, which included a ban on high phosphorus deterepts and the addition of reciamation measures, which included a ban on high phosphorus detergents and the addition of secondary and tertiary processes at the adjoining sewage treatment plant. Significant reductions in lake phytoplankton concentrations have not ac-companied the reduction in phosphorus loading, indicating the lake remains nutrient-saturated. An unusually high fraction of phosphorus received by the lake is retained, apparently as a result of enhanced phosphorus deposition associated with the industrial loading of ca'cium from an adjoining chloralkali manufacturer. One-tenth of the reported substantial reductior in phosphorus loading to Lake Ontario from 1970-1979 is attributable to the reduction in loading to Onondaga Lake. The nature of the phosphorus associations in the lake's sediments indicates that sediment interactions should not act to compensate for further reductions in external phosphorus loading. (Author's W84-03471

## CADMIUM ADSORPTION BY AEROBIC LAKE

Oregon State Univ., Corvallis. Dept. of Civil Engi-

J. O. Wiley, and P. O. Nelson.

Journal of Environmental Engineering, Vol. 110, No. 1, p 226-243, February, 1984. 9 Fig, 7 Tab, 51

Descriptors: \*Cadmium, \*Lake sediments, \*Adsorption, Fate of pollutants, Hydrogen ion concentration, Ligands, Sediments, Iron, Manganese, Partical size, Chemical speciation, Suspended solids, Organic compounds.

Factors that influence the adsorption of cadmium on aerobic lake sediments were investigated, in-cluding sediment type, pH, and soluble ligand composition. Conditional adsorption constants were experimentally determined for sediments samples in native lake water from Sturgeon Lake, Oregon. Correlation of adsorption constant values with sediment characteristics including mean grain size, iron and manganese content, volatile solids content, and cation exchange indicated significant dependence only on mean grain size. Another approach, using specific geochemical phase adsorption constants from another study to assess that phase's contribution to adsorption, predicted that iron oxides controlled cadmium adsorption. A speciation-distribution model for cadmium in the water column indicated that the dominant chemiwater column indicated that the dominant chemical forms were the free cadmium ion and cadmium adsorbed to suspended solids. As pH increased from 5 to 9, the adsorbed fraction increased and the free ionic fraction decreased markedly. Organic ligand complexes were predicted to be the dominant soluble cadmium complex in the neutral pH range, while the cadmium carbonate dominated at pH 9. (Author's abstract) W84-03477

## CRITICAL POINT METHOD FOR MIXING ZONES IN RIVERS,

Gore and Storrie Ltd., Toronto (Ontario). Water T. P. H. Gowda

#### Field 5-WATER QUALITY MANAGEMENT AND PROTECTION

#### Group 5B-Sources Of Pollution

Journal of Environmental Engineering, Vol. 110, No. 1, p 244-261, February, 1984. 9 Fig. 4 Tab, 23

Descriptors: \*Mixing, \*Path of pollutants, \*Critical point, Effluents, Chlorine, Ammonia, Outfalls, Rivers.

Expressions for the coordinates of a critical point, occurring along a given lateral boundary of a limited use zone within a mixing zone below a bank outfall in a river channel, are developed. A family of curves is developed for a range of dimensionless coordinates of the critical point. An expression for allowable effluent concentration of a pollutant is obtained in terms of critical concentration and water quality criterion. A graphical procedure for determining the longitudinal boundary of a limited use zone is described. The predictions of the critical point method are validated using total residual chlorine distribution data from a natural stream. The application of the methodology is outlined in a step-by-step design procedure and illustrated by an example for ammonia. In general, the method is applicable to exponentially decaying nonconservative pollutants. (Author's abstract) Expressions for the coordinates of a critical point,

ELEVATED CONCENTRATIONS OF HUMIC SUBSTANCES IN A SEASONALLY ANOXIC HYPOLIMNION: EVIDENCE FOR CO-ACCU-MULATION WITH IRON, Freshwater Biological Association, Ambleside

(England). E. Tipping, and C. Woof. Archiv fur Hydrobiologie, Vol. 98, No. 2, p 137-145, October, 1983. 4 Fig. 2 Tab, 24 Ref.

Descriptors: \*Decomposing organic matter, \*Hypolimnion, Thermal stratification, Seasonal variations, Iron, Accumulation, Sediments, Algae, Iron oxide, Esthwaite Water, Fate of pollutants.

Humic substances (HS) are a major fraction of rounic substances (ris) are a major naction of soluble organic matter in natural waters. They influence the chemical speciation of metals, bind hydrophobic pollutants such as DDT, and play a significant role in environmental surface chemistry. HS are a potential hazard in waters used for doris are a potential nazard in waters used for do-mestic supply since they react with chlorine to yield trihalomethanes, possible carcinogens. For these reasons, factors which determine humic con-centrations in natural waters are of wide relevance. Increases in the concentration of humic substances in the anoxic hypolimnion of Esthwaite Water are correlated with increases in the concentration of iron. This finding supports the theory of a mechanism whereby humic substances are accumulated by co-sedimentation with iron oxide particles. Subsequently the humic substances follow the move-ments of iron during its redox cycling in the hypolimnion and sediment. Unsuccessful attempts w made to distinguish epilimnetic and hypolimne humic substances by spectroscopic and gel chro-matographic means. Therefore no evidence for an alternative mechanism of humic accumulation was found such as the anaerobic decomposition of sedi-mented dead algae. (Baker-IVI) W84-03488

ENDOGENIC FLUX OF MANGANESE TO THE BOTTOM OF LAKE CONSTANCE, Konstanz Univ. (Germany, F.R.). Fakultaet fuer

4

Physik. H.-H. Stabel, and J. Kleiner. Archiv fur Hydrobiologie, Vol. 98, No. 3, p 307-316, November, 1983. 4 Fig. 1 Tab, 25 Ref.

Descriptors: \*Manganese, \*Fate of pollutants, \*Bottom sediments, Lakes, Lake Constance, Sedimentation, Hypolimnion, Thermal stratification.

The manganese content of the sediment particles The manganese content of the sediment particles trapped at greater depths was generally enhanced relative to that found in the upper layers. Three reasons may be responsible for this. Degradation of oganic matter during the settling process, and redissolution of calcite in deeper layers may lead to a relative enrichment of more stable inorganic constituents. Resuspension of bottom sediments richer in Mn than the particles moving vertically from

upper layers may occur. In addition, an eodogenic oxidation of Mn(2+) into Mn(4+) occurs within the hypolimnion of Lake Constance. The Mn(4+) precipitates, mainly gamma-MnOOH, add to the vertical flux of Mn-containing particles, deriving from planktonic and allochthonous sources. (Baker-IVI)

#### 5C. Effects Of Pollution

THE RECOVERY OF THE BIOTIC COMMU-NITY IN A LOTIC FRESHWATER HABITAT AFTER EXTENSIVE DESTRUCTION BY CHLORINE

CHLORINE, Hamburg Univ. (Germany, F.R.). Inst. fuer Hy-drobiologie und Fischereiwissenschaft. C. W. Heckman. Internationale Revue der Gesamten Hydrobiolo-gie, Vol. 68, No. 2, p 207-226, 1983. 2 Fig, 2 Tab, 745 p. dr.

Descriptors: \*Biotic recovery, \*Lotic environment, \*Chlorine, Ecological effects, Aquatic populations, Population dynamics, Population exposure, Fauna, Residual chlorine.

The recovery of a temperate zone biotic communi-ty in a lotic freshwater habitat after acute chlorine poisoning was nearly completed in four months (May to September). The water flow facilitated the removal of the toxic residues of the chlorine and transported organisms from the intact community upstream into the impoverished habitat. The first aggregation in the ditch after the chlorine was eliminated consisted of survivors, including memeliminated consisted of survivors, including mem-bers of species that failed to produce new genera-These were joined by pioneer species of the les Simulidae and Chironomidae, the larvae of families Simulidae and Chironomidae, the larvae of which appeared in massive numbers. This aggregation was displaced by a more diverse fauna as the macroflora and microbiota re-established themselves, providing food and anchorage for the invertebrates. The populations of large fishes are slowest to return because a considerable amount of time is required for the migration and growth of the recruits. While the chronic intoxication of a habitat produces changes in community structure, an acute poisoning is followed by a nearly complete restoration of the original biota, the recovery time being determined by the proximity of recruits for resetdetermined by the proximity of recruits for reset-tlement. (Murphy-IVI) W84-02951

THE DISTRIBUTION OF DESMOGNATHINE LARVAE (AMPHIBIA: PLETHODONTIDAE) IN COAL SURFACE MINE IMPACTED STREAMS OF THE CUMBERLAND PLATEAU,

USA, Tulsa Univ., OK. Faculty of Natural Sciences. For primary bibliographic entry see Field 2H. W84-02961

THE DESMIDS AND PHYSICAL CHARAC-TERISTICS OF 100 LAKES IN NORTHEAST-ERN PENNSYLVANIA, Wilkes Coll., Wilkes-Barre, PA.

For primary bibliographic entry see Field 2H. W84-02962

THE DISTRIBUTION AND ACCUMULATION OF ALUMINUM IN RAINBOW TROUT FOL-LOWING A WHOLE-LAKE ALUM TREAT-MENT,

Eastern Washington Univ., Cheney. Dept. of Biology. For primary bibliographic entry see Field 5B. W84-02963

AN INDEX OF COMMUNITY STRUCTURE AN INDEX OF COMMUNITY STRUCTURE SENSITIVE TO WATER POLLUTION, Georgia State Univ., Atlanta. Dept. of Biology. F. K. Parrish, and J. A. Wagner. Journal of Freshwater Ecology, Vol. 2, No. 2, p 103-107, July, 1983. 2 Tab, 7 Ref.

Descriptors: \*Benthic environment, \*Water pollution effects, Macroinvertebrates, Invertebrates,

Population dynamics, Species diversity, Water

To quantify pollutional stress utilizing macroinver-To quantify pollutional stress utilizing macroinvertebrate community composition, an average chisquare test was used with considerable success. The method is presented for further testing. A conceptually simple index, the average chi-square value, is presented which compares and ranks poltuted vs unpolluted streams within a geographic area. It uses all data from a sample, requires only that comparable or equal numbers of samples be used to compare two sites and provides a summary value which has been found to give consistently satisfactory results. (Baker-IVI)

LAKE ONTARIO'S FISH - HOW THEY ALMOST GOT AWAY.

S. Peterson. Environment, Vol. 25, No. 9, p 25-32, November, 1983. 6 Fig, 32 Ref.

Descriptors: \*Fish, \*Water pollution effects, \*Lake Ontario, Great Lakes, Polychlorinated biphenyls, Dioxin, Mirex, Salmon, Fisheries, Pesticides, Lamprey, Alewife, Smelt.

The history of fish populations in Lake Ontario is reviewed. Two hundred years ago the lake supported what has been thought to be the world's largest population of land-locked salmon. By the end of World War II practically all commercially valuable fish species in this lake were gone. Currently sportsmen again are catching trophy size chinook salmon in that lake, but now these fish are contaminated with pollutants which renders them unsafe for consumption more than once a month, and unsafe for children and women of child bearing age in any amount. As lands bordering Lake Ontario were cleared and settled, nearly every sizable stream was dammed in order to power sizable stream was dammed in order to power Ontain were cleared and settled, nearly every sizable stream was dammed in order to power industrial mills. Dams and pollution took their toll on the lake population. The next happening was direct exploitation by developing gill-net fisheries. One of the most dramatic results of man's impact on the Great Lakes has been the spectacular success of several invarience mericia reservoirs of fisheries. cess of several invading marine species of fish, which have profoundly altered the ecology of the lakes. Among these are the lamprey, alewife and smelt. The presence in the lake of PCBs, dioxins, and mirex are of particular concern to area residents and fish managers. (Baker-IVI)

NICKEL TOXICITY TO ESTUARINE/MARINE FUNGI AND ITS AMELIORATION BY MAG-NESIUM IN SEA WATER,

New York Univ., NY. Lab. of Microbial Ecology. H. Babich, and G. Stotzky. Water, Air, and Soil Pollution, Vol. 19, No. 2, p 193-202, 1983. 2 Fig, 5 Tab, 22 Ref.

Descriptors: \*Seawater, \*Nickel, \*Toxicity, \*Fungi, Sodium, Chloride, Magnesium, Salinity, Mycelial, Marine plants, Estuarine environment.

Mycelial growth rates of five estuarine/marine fungi were determined on the non-marine and on the marine nutrient medium in the absence and presence of progressively increasing levels of nickel. In the absence of nickel growth rates were greater on the marine medium. Furthermore, the fungi tolerated nickel better when exposed on the fungi tolerated nickel better when exposed on the marine than on the non-marine medium. When grown on the non-marine medium amended with nickel, incipient growth inhibition for Pleospora nickel, incipient growth inhibition for Pleospora vagens was evident at a concentration between 10 and 30 ppm Ni for Dendryphiella salina, Asteromyces cruciatus, and Dreschlera halodes at 50 ppm nickel, and for Buergenerula spartinae at a concentration greater than 50 ppm Ni. Total growth inhibition on the non-marine medium occurred at 50 ppm Ni for P. vagens, at 100 ppm Ni for D. salina, B. spartinae, and A. cruciatus, and at 250 ppm Ni for D. halodes. When grown on the marine medium, incipient growth inhibition occurred at 50 ppm Ni for P. vagens, A. cruciatus, and D. halodes, at 100 ppm Ni for D. salina, and at 250 ppm Ni for B. spartinae. Total growth inhibition

#### WATER QUALITY MANAGEMENT AND PROTECTION—Field 5

#### Effects Of Pollution-Group 5C

tion occurred at 500 ppm Ni for P. vagens, D. salina, B. spartinae, and A. cruciatus, and D. halodes exhibited some growth even at 500 ppm Ni. The ameliorating effect of seawater or salinity on the toxicity of Ni to mycelial proliferation was related to the Mg, rather than to the Na or Cl ions in the marine systems. The mechanism by which seawater reduced Ni toxicity is apparently different from the mechansism whereby seawater reduced the toxicity of Cd and Hg. (Baker-FRC) W84-02988

STUDIES ON BACTERIOLOGICAL QUALITY OF NAINITAL LAKE WATER IN DIFFERENT SEASONS, Kumaun Univ., Naini Tal (India). MAB/DST

Lakes Project.
For primary bibliographic entry see Field 5B.
W84-02989

POTENTIAL PHYTOTOXICITY OF DIQUAT ACCUMULATED BY AQUATIC PLANTS AND SEDIMENTS,
York Univ., Downsview (Ontario). Dept. of Biol-

ogy.
B. C. Birmingham, and B. Colman.
Water, Air, and Soil Pollution, Vol. 19, No. 2, p 123-131, 1983. 2 Fig, 4 Tab, 24 Ref.

Descriptors: \*Phytotoxicity, \*Aquatic plants, \*Sediments, \*Organic compounds, Herbicides, Diquat, Bipyridilium, Lake sediment, Boassays, Water pollution effects.

The adsorption and desorption of Reglone A was The adsorption and desorption of Reglone A was studied on freshwater algae grown in culture, Eurasian water milfoil, and greenhouse soil-sand mixture. The data was needed to examine the potential for phytotoxicity of diquat residues in aquatic ecosystems. The nitrogen fixing blue-green alga, Anabaena flos-aquae and a duckweed were used as bioassay organisms to test for residual phytotoxicity once the diquat was bound to the soil. Reglone inhibited the growth of blue-green algae at conceninhibited the growth of blue-green algae at concentrations greater than 0.03 ppm. Eukaryotic algae were less sensitive, growth of Navicula pelliculose was inhibited at concentrations exceeding 0.3 ppm and Chlorella vulgaris was unaffected by 3 ppm Reglone. In the presence of soil, growth inhibition by Reglone was eliminated. Reglone was added to by Reglone was eliminated. Reglone was added to a water-soil mixture system up to 334 ppm to simulate chronic usage. Significant growth inhibition occurred to both bioassay plants in soil treated with 33.4 ppm Reglone and the 334 ppm treatment was lethal. It is suggested that residual phytotoxicity becomes apparent in this soil system at about 7% of the diquat adsorption capacity. The Reglone adsorption-desorption isotherm of a natural, organical lake sediment was measured to predict the number of Reglone treatments at the recommend-of application rate before residual phytotoxicity ed application rate before residual phytotoxicity would become apparent. (Baker-FRC)

DELAYED TOXICITY OF CARBOFURAN IN FRESHWATER TELEOSTS, CHANNA PUNCTATUS (BLOCH) AND ANABAS TESTUDIN-EUS (BLOCH), Visva Bharati Univ., Santiniketan (India). Environ-

mental Toxicology Lab.
N. B. Jash, and S. Bhattacharya.

Water, Air, and Soil Pollution, Vol. 19, No. 3, p 209-213, 1983. 2 Tab, 10 Ref.

Descriptors: \*Toxicity, \*Organic compounds, \*Pesticides, \*Fish, Water pollution effects, Organophosphates, India, Aquatic life.

In vitro inhibition of brain acetylcholinesterase from Channa punctatus and Anabas testudineus was compared between control and Carbofuran treated fish. A dose dependent in vivo inhibition was recorded in both species of fish. On transfer to pesticide free fresh water there was immediate recovery of AChE activity within 30 days only in those fish treated with the highest dose of Carbofuran. During the sojourn of fish in Carbofuran free water there appears to be a gradual dissociation of the incorporated inhibitor from the enzyme, which occurs at a faster rate in fish treated with

highest concentrations of carbofuran. Delayed toxicity of the lower concentrations of carbofuran was more conspicuous in Channa punctatus although it is apparently more resistant to carbofuran than Anabas testudineus. (Baker-FRC) W84-02992

PERIPHYTON BIOMASS AND SPECIES COM-POSITION IN A COASTAL RAINFOREST STREAM IN BRITISH COLUMBIA: EFFECTS OF ENVIRONMENTAL CHANGES CAUSED

OF ENVIRONMENTAL CHANGES CAUSED BY LOGGING, Fisheries and Marine Service, Vancouver (British Columbia). Vancouver Lab. K. S. Shortreed, and J. G. Stockner. Canadian Journal of Fisheries and Aquatic Sciences, Vol. 40, No. 11, p 1887-1895, November, 1983. 6 Fig. 1 Tab, 26 Ref.

\*Environmental effects, streams, "Logging, British Columbia, Carnation Creek, Phosphorous, Biomass, Algae, Chlorophyta, Diatoms, Solar radiatior, Periphyton, Clear-cutting, Water temperature.

Periphyton biomass, species composition, and ac-cumulation rates on Plexiglas substrates were decumulation rates on Piecujas substrates were de-termined in a 6-yr study from 1974 to 1979 in Carnation Creek, Vancouver Island, British Co-lumbia. During the first 2 years of the study, the watershed was unlogged. Clearcut logging during the remainder of the study resulted in increases in light intensity of over 100% at some sites, with slight increases in stream temperature (2-3 degrees C in summer) and increases in some dissolved ion C in summer) and increases in some dissolved ion concentrations. Phosphorus concentrations were similar throughout. Diatoms were the most common class of algae, and Achnanthes minutissima and Synedra rumpens were the most common diatoms. Filamentous chlorophytes (predominantly Mougeotia sp. with some Draparnaldia sp., Spirogyra and Zygnema sp.) occurred sporadically throughout the study but were more common after logging, primarily as a result of increased light intensity. The highest recorded periphyton biomass and accumulation rates occurred after logging. Post-logging values were generally similar to those Post-logging values were generally similar to those recorded prior to logging due to the lack of increased phosphorus concentrations after logging. (Murphy-IVI) W84-03016

CONTAMINANT ACCUMULATION AND PHYSIOLOGICAL RESPONSE IN RAINBOW TROUT (SALMO GAIRDNERI) REARED ON NATURALLY CONTAMINATED DIETS,

Guelph Univ. (OntaminATED DIETS, Guelph Univ. (Ontario). Dept. of Nutrition. J. W. Hilton, P. V. Hodson, H. E. Braun, J. L. Leatherland, and S. J. Slinger. Canadian Journal of Fisheries and Aquatic Sciences, Vol. 40, No. 11, p 1987-1994, November, 1983. 6 Tab, 21 Ref.

Descriptors: \*Physiological response, \*Trout, \*Bioaccumulation, Salmon, Fish food, DDT, Chlordane, Dieldrin, Polychlorinated biphenyls, Aquaculture, Mirex, Lake Michigan, Lake Ontar-

Juvenile rainbow trout were reared for 24 weeks on practical-type diets formulated with fish meals of coho salmon (Oncorhynchus kisutch) from Lake Michigan, Lake Ontario, and the Pacific Ocean. Levels of contaminants (DDT, chlordane, dieldrin, mirex and polychlorinated biphenyls) increased 10-fold from control and Pacific Ocean salmon-based fold from control and Pacific Ocean salmon-based diets to Lake Ontario salmon-based diets. Rainbow trout accumulated contaminants in direct proportion to dietary levels. There were no significant differences in the final body weights, feed to gain ratios, or mortality rates of the trout. There were no signs of abnormal behavior or histopathological abnormalities. There were no signs of thyroid hyperplasia or significant decline in serum T3 or T4 levels with increasing dietary contaminant levels. The rainbow trout were not affected by the uptake and accumulation of contaminants. The trout did not regulate their body burden of contaminants, which could be toxic and adversely affect their reproductive cycle. The final concentrations of mirex and PCBs in Lake Ontario-fed fish exceeded

the allowed limits to protect human health. The fish meals produced from Lake Ontario salmon are unsuitable as a source of feed for aquaculture of rainbow trout intended for human consumption. (Murphy-IVI)

GEOTHERMAL EFFECTS ON STREAM BENTHOS: SEPARATE INFLUENCES OF THERMAL AND CHEMICAL COMPONENTS ON PERIPHYTON AND MACROINVEXTE-

California Univ., Berkeley. Div. of Entomology and Parasitology.

G. A. Lamberti, and V. H. Resh.

Canadian Journal of Fisheries and Aquatic Sciences, Vol. 40, No. 11, p 1995-2009, November, 1983. 8 Fig. 3 Tab, 40 Ref. OWRT project A-084-CAL, Water Resources Center Project UCAL-WRC-W-612.

Descriptors: \*Benthos, \*Thermal springs, \*Envi-ronmental effects, \*Geothermal fluids, \*Stream biots, Thermal stress, Chemical composition, In-vertebrates, Geothermal power, Big Sulphur Creek, The Geysers, California.

The largest geothermal energy development in the world is located at The Geysers in northern California, but the full development of geothermal resources at The Geysers and in other areas has been delayed because of potential environmental impact, especially on aquatic biota. Stream micro-cosms were used in situ to evaluate the separate effects of the thermal and chemical components of effects of the thermal and chemical components of geothermal fluids from natural hot springs on benthic microorganisms and macroinvertebrates of Big Sulphur Creek, a third-order stream at The Geysers. The thermal component of geothermal fluids had greater influence than the chemical component in determining benthic community features. A natural input of geothermal fluids elevated both the temperature (by 7.5 degrees) and chemical levels (boron by 10 times, NO3-N by 4 times, PO4-P by 2 times), increased benthic chlorophyll a by 40 times, bacterial numbers by 10 times, and ma-P by 2 times), increased benthic chlorophyll a by 40 times, bacterial numbers by 10 times, and macroinvertebrate density by 2 times. Heating of nongeothermal water by 8 degrees increased chlorophyll a by 40 times and bacterial numbers by 2 times, but macroinvertebrate density declined by one fourth. Cooling of geothermal water by 14.5 degrees reduced algal productivity but increased macroinvertebrate density by 70 times. Naturally occurring geochemical concentrations annarentia occurring geochemical concentrations apparently can be tolerated by aquatic organisms, but changes in water temperature significantly alter benthic community structure. (Murphy-IVI) W84-03019

INFLUENCE OF DETERIORATING WATER QUALITY ON GROWTH AND DEVELOPMENT OF CHUM SALMON (ONCORHYN-MENT OF CHUM SALMON (ONCORHYN-CHUS KETA) LARVAE IN A JAPANESE-STYLE KEEPER CHANNEL, Department of Fisheries and Oceans, Nanaimo (British Columbia). Pacific Biological Station. R. A. Bams, and C. N. H. Lam.

Canadian Journal of Fisheries and Aquatic Sciences, Vol. 40, No. 11, p 2098-2104, November, 1983. 1 Fig. 2 Tab, 27 Ref.

Descriptors: \*Water pollution effects, \*Salmon, \*Larvae, \*Keeper channels, Aquaculture, Growth, Dissolved oxygen, Fish farming, Ammonia.

Chum salmon (Oncorhynchus keta) larvae were incubated in gravel filled cages placed in two experimental Japanese-style keeper channels having 40 and 80 L/min total flow, at three successive locations having 0, 46,000, and 92,000 eggs (or alevins) upstream. Minimum dissolved oxygen was 6.21 mg/L. Maximum un-ionized ammonia was 0.18 microgram/L. The pH varied from 7.18 to 6.83, and temperature ranged from 7.8 to 8.2 C. Preemergent fry showed small but significant decreases in mean fork length, with increasing distance along both channels 50 days after hatching weights decreased similarly but nonsignificantly in both channels. Stage of development was constant in all locations except the bottom location of the

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low-flow channel, which showed a significantly delay. Survival was uniformly high with no differ-ential mortality among locations or flow rates. The ential mortality among locations or flow rates. The deteriorating water quality measurably reduced larval development rate, growth rate, and yolk-conversion efficiency. The main effective factor was dissolved oxygen. Standard channel loading and flow criteria are adequate for short incubation channels only. (Murphy-IVI) W84-03020

ACUTE EFFECTS OF TOXAPHENE AND ITS SEDIMENT-DEGRADED PRODUCTS ON ES-TUARINE FISH.

South Carolina Univ., Columbia.

H. W. Harder, T. V. Carter, and T. F. Bidleman.

Canadian Journal of Fisheries and Aquatic Sciences, Vol. 40, No. 12, p 2119-2125, December, 1983.

4 Fig. 1 Tab, 23 Ref.

Descriptors: \*Toxaphene, \*Estuarine environment, \*Toxicity, \*Fish, Degradation products, Pesticide residues, Sediments, Bioassay, Bioaccumulation.

The acute effect of toxaphene and the dechlorinat-The acute effect of toxaphene and the electhornan-ed products that are formed in reducing sediments were determined for two estuarine fish, spot (Leiostomus xanthurus) and white mullet (Mugil curema). The reductively dechlorinated mixture was prepared by incubating toxaphene with anoxic salt marsh sediment for three weeks and isolating the products, then analyzed by packed and glass capillary gas chromatography. The 96-h LC50 for toxaphene was 0.92 and 2.88 micrograms/L for spot and mullet, respectively. Sediment degraded toxaphene was almost as toxic to spot (LC50 = toxaphene was amost as toxic to spot (LC30 = 1.0 microgram/L) as the parent pesticide. The mullet were three times more susceptible to the degraded form (LC30 = 1.02 microgram/L). Bioaccumulation was similar for both forms of toxaphene, with factors of 2000-6000 over the 96-h exposure period. Short-term degradation of toxaexposure period. Short-term degradation of toxaphene in anoxic sediments does not apear to reduce its toxicity; the degraded toxaphene produced has as much potential for causing acute poisoning to fish as the parent pesticide. Analytical searches for toxaphene residues in environmental samples should not be restricted to gas chromatography patterns matching those of the parent compound but should also consider the degraded toxaphene fingerprints. (Murphy-IVI)
W\$4-03021

RETROSPECTIVE ANALYSIS OF THE RESPONSE OF SAGINAW BAY, LAKE HURON, TO REDUCTIONS IN PHOSPHORUS LOAD-

ental Research Lab.-Duluth, Grosse Ile, Enviro MI. Large Lakes Research Station.
V. J. Blerman, Jr., D. M. Dolan, R. Kasprzyk, and

J. L. Clark. Environmental Science and Technology, Vol. 18, No. 1, p 23-31, January, 1984. 7 Fig, 5 Tab, 40 Ref.

Descriptors: \*Saginaw Bay, \*Lake Huron, \*Phosphorus, Biomass, Chlorophyll a, Phytoplankton, Cyanophyta, Turbidity, Sediment resuspension, Odor, Drinking water.

Control of phosphorus inputs to lakes is one of the principal means for attempting to reverse the symptoms of cultural eutrophication. Through a retrospective (1974-1980) analysis of Saginaw Bay, Lake Huron, loadings to the bay from the Saginaw River for total phosphorus and dissolved ortho phosphorus were 55% and 72% lower, respectively, in 1980 than in 1974. In the most seriously degraded area of the bay, spring and fall total phosphorus concentrations decreased by 1% and 14%, respectively, while chlorophyll a concentrations decreased by 53% and 61% in the same seasons. The corresponding decreases for inverse Secchi depth were 0% and 17%. Sediment resuspension due to wind-induced wave action was the probable cause for the anomalous relationship be-Control of phosphorus inputs to lakes is one of the spension due to wind-induced wave action was the probable cause for the anomalous relationship be-tween chlorophyll a and total phosphorus concen-trations, and the lack of response of inverse Secchi depth. A substantial decrease in threshold odor in the municipal water supply was correlated with a decrease in blue-green dry weight biomass concen-tration. The change was poorly correlated with

blue-green cell number, total phytoplankton dry weight biomass, or chlorophyll a concentrations. (Murphy-IVI) W84-03033

FISH/SEDIMENT CONCENTRATION RATIOS FOR ORGANIC COMPOUNDS, Harvard School of Public Health, Boston, MA. Interdisciplinary Programs in Health.

M. S. Connor.

Environmental Science and Technology, Vol. 18, No. 1, p 31-35, January, 1984. 3 Fig, 1 Tab, 32 Ref.

Descriptors: \*Fish, \*Sediments, \*Organic compounds, Chlorinated hydrocarbons, Hydrocarbons, Water pollution effects, Mollusks, Crustaceans, Mathematical studies, Partition coefficients, Hydraulic retention time, Flushing capacity.

Applying a bioconcentration factor directly to pre-dict the potential for the contamination of fish by toxic organic compounds may be insufficient in the field. Partition coefficients make accurate predic-tions of contamination in short-term laboratory tests, but in the environment, biological and physi-cal factors play an important role. The concentra-tion ratio of chlorinated or polynuclear aromatic hydrocarbons in fish to the sediments from their habitat increases with hydraulic retention time of the basin. Fish/sediment ratios for chlorinated hy-drocarbons are about three orders of magnitude higher than for aromatic hydrocarbons with the same octanol-water partition coefficient. Normaliz-ing for sediment concentrations and animal concentrations of chlorinated aromatic hydrocarbons, the body burdens of polynuclear aromatic hydro-carbons in different phyletic groups are consistent with the inverse of their mixed-function oxygenase activity. The order for the concentrations lusks > polychaetes = crustaceans > fish. The consistent behavior of classes of compounds allows extrapolation from data for individual compounds to a variety of pollutants in aquatic environments where the flushing capacity has been determined. (Murphy-IVI) W84-03034

CHEMISTRY AND MICROBIOLOGY OF A SEWAGE SPILL IN SOUTH SAN FRANCISCO BAY,

Geological Survey, Menlo Park, CA. J. E. Cloern, and R. S. Oremland. Estuaries, Vol. 6, No. 4, p 399-406, December, 1983. 3 Fig., 2 Tab, 25 Ref.

Descriptors: \*Wastewater, \*Spills, \*Water pollu-tion effects, Bays, San Francisco Bay, Estuaries, Wastewater treatment facilities, Primary wastewater treatment, Secondary wastewater treatment, Dissolved oxygen, Methane, Ammonia.

The breakdown of a waste treatment plant resulted in the discharge of a large volume of primary treated sewage into a tributary of South San Fran-cisco Bay, California during three weeks of Sep-tember 1979. Chemical and microbial changes octemoer 1979. Chemical and microbial cranges oc-curred within the tributary as decomposition and nitrification depleted dissolved oxygen. Associated with anoxia were relatively high concentrations of particulate organic carbon, dissolved carbon diox-ide, methane, C2H2, ammonia and fecal bacteria along with low phytoplankton biomass and photo-synthetic oxygen production. After the sewage treatment plant resumed its normal activities the Coyote Creek experienced radical biochemical nges as it shifted from anaerobic to aerobic changes as it surface from anaeronic to aeronic conditions. Most rapid changes were noted in CH4 and C2H4 concentrations. Within two weeks par-ticulate organic carbon decreased and dissolved oxygen increased to apparently normal levels. The oxygen increased to apparently normal levels. The rapid chemical changes were accompanied by in-creases in phytoplankton biomass. Two principles associated with the discharge of sewage into estu-aries were exemplified by the study: first, the finite capacity of receiving waters to assimilate wastes, and secondly, that the aquatic ecosystems are resilient, even to extreme perturbations. (Baker-IVI) W84-03038

EFFECTS OF INDUSTRIAL BOILER BLOW-DOWN DISCHARGES ON STREAMS,

Tennessee Dept. of Public Health, Nashville. J. C. Spangler.
Pollution Engineering, Vol. 25, No. 9, p 44-45, 1983. 2 Fig.

Descriptors: \*Wastewater treatment, \*Monitoring, Acidity, Sulfites, Sulfates, Dissolved solids, Oxygen demand, Suspended solids, Boiler blow-

Boiler blowdown is primarily for elimination of boiler sludge and dissolved solids. Before the blowdown is discharged, it should be treated to comply with effluent guidelines instead of diluting the discharge with other discharges. The following parameters are recommended for monitoring and reporting on an individual case basis for boiler reporting on an individual case basis for boiler blowdown discharges to other than publicly owned treatment works: biochemical oxygen demand, total suspended solids, pH, sulfites, chemical oxygen demand, settleable solids, ammonia, oil and grease, and sulfates. (Baker-IVI)

PREDICTING ALGAL STIMULATORY PROP-ERTIES OF WASTEWATER,

Massachusetts Univ., Amherst N. M. Ram, and P. E. Austin. No. 7, 10 August 1983. August 1983. August 1994. 109, No. 5, p 1099-1110, October, 1983. 6 fig, 2 Tab, 19 Ref. WDWPC project 80-30.

Descriptors: \*Prediction, \*Algae, \*Biological properties, \*Wastewater, Municipal Sewage, Inorganic nitrogen, Inorganic phosphorus, Algal growth, Biodegradation.

Discharge of wastewater effluent into the aquatic environment is of environmental concern because of the resulting eutrophication or nutrient of receiving waters leading to decreased water quality. The Algal Assay: Bottle Test (AA:BT) is a useful tool in evaluating the bioavailable nutrients in nat-ural waters and wastewater effluents. The AA-BT did not permit sufficient organic mineralization during incubation, owing to the exclusion of heterotrophic bacteria and protozoa by the test procedure. This occurrence could result in an underestimation by the AA:BT of the algal growth potential occurring from the entry of a wastewater contain-ing inorganic and organic nitrogen and phosphorus compounds (Murphy-IVI) into the aquatic

TEMPERATURE, PH, SALINITY, HARDNESS, AND PARTICULATES MEDIATE NICKEL TOXICITY TO EUBACTERIA, AN ACTINOMY-CETE, AND YEASTS IN LAKE, SIMULATED ESTUARINE, AND SEA WATERS,

New York Univ., NY. Lab. of Microbial Ecology. H. Babich, and G. Stotzky. Aquatic Toxicology, Vol. 3, No. 3, p 195-208, April, 1983. 10 Fig. 24 Ref. EPA grant R808329.

Descriptors: \*Temperature, \*Hydrogen ion con-centration, \*Salinity, \*Hardness, \*Particulate matter, \*Nickel, \*Toxicity, \*Eubacteria, \*Actino-mycete, \*Yeasts, \*Lakes, \*Estuarine environment, \*Seawater, Heavy metals, Water pollution effects, Water quality standards, Environmental factors.

Little is known about the effects of Ni on marine microorganisms. Even less is known about the influence of abiotic environmental factors on the toxicity of Ni to marine organisms, especially to the microbiota. Information on the survival of some eubacteria, an actinomycete, and yeasts after acute and chronic exposures to nickel (Ni) in lake, simulated estuarine, and sea waters and the influence of environmental factors on Ni toxicity will help to determine water quality standards. Criteria that do not adequately consider differences in the physicochemical characteristics of various aquatic ecosystems will be over-protective for some eco-systems and under-protective for others. Nickel toxicity to microbes in marine systems is reduced by increasing the salinity, by decreasing the tem-perature, and by the incorporation of simulated

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sediment. The toxicity of Ni to microbes in fresh water is reduced by increasing the pH, by increas-ing the hardness, and by the incorporation of su-pended particulates. In chronic toxicity fresh waters are more sensitive than marine waters to Ni pollution, as microbial survival is greater in marine than in fresh waters stressed with equivalent con-centrations of Ni. (Murphy-IVI) W84-03111

RAINBOW TROUT AND HUMAN CELLS IN CULTURE FOR THE EVALUATION OF THE TOXICITY OF AQUATIC POLLUTANTS: A STUDY WITH CADMIUM, Quebec Univ., Montreal. Dept. de Chemie. M. Marion, and F. Denizeau. Aquastic Toxicology, Vol. 3, No. 4, p 329-343, May, 1983. 4 Fig, 28 Ref.

Descriptors: \*Rainbow trout cells, \*Human cells, \*Toxicity, \*Aquatic pollutants, \*Cadmium, Bioas-say, Bioaccumulation, Detection limits, Water quality, Comparison studies, Correlation analysis.

Rainbow trout (RTG-2) and human skin epithelial cells (NCTC 2544) as bioassay organisms evaluated the toxicity of the aquatic pollutant cadmium (Cd). The cell lines were grown as monolayers at 15 (RTG-2) and 37 degree C (NCTC 2544) in minimal essential medium supplemented with 10% fetal bovine serum (FBS). RTG-2 and NCTC 2544 cells exposed to 100 ppb and 2.4 ppm Cd was maintained for a period of time sufficient for an inoculum of 105 cells (RTG-2) or 50,000 cells (NCTC 2544) to reach confluence in the controls in a 60-2541 to reach confluence in the controls in a 60-2544) to reach confluence in the controls in a 60-mm Petri dish: 20 days for RTG-2 and 9 days for NCTC 2544. Every 2 days (RTG-2) or every day (NCTC 2544) the medium was renewed and 3 Petri dishes were used to determine the total pro-tein, total DNA, total RNA content and the incor-poration of H-3 thymidine in DNA and C-14 uriporation of H-3 thymidine in DNA and C-14 uri-dine in RNA. The cytotoxicity of Cd was apparent only when the serum concentration in the medium was reduced. With 1% FBS in the medium Cd induced a dramatic inhibition in the increase of total protein DNA and RNA content of RTG-2 cells. At 2.4 ppm, this occurred as early as 5 days (protein and RNA) after Cd was added to the cultures. The incorporation of labelled precursors was equally much lower in the treated samples (2.4 ppm) compared to the controls. At 100 pph, 2.4 was equally much rower in the treated samples (2.4 ppm) compared to the controls. At 100 ppb, only the incorporation of C-14 uridine in RNA was affected after 10 days of exposure and persisted until the end of the experiment. NCTC 2544 cells until the end of the experiment. NCTC 2544 cells appeared to be more sensitive to cadmium than RTG-2 cells. At 2.4 ppm, as seen with trout cells, there was a severe depression in all the parameters. However, at 100 ppm, contrasting with RTG-2 cells, significant differences were at least on 4 parameters (protein, DNA, RNA and C-14 incorporation). The complete assessment of the reliability of cell culture systems for the evaluation of toxicity will be achieved through the establishment of a strong correlation between in vivo and in vitro of a strong correlation between in vivo and in vitro responses. This is considered an important step in the process of validation of the present bioassay system. (Murphy-IVI) W84-03114

EFFECTS OF ACCUMULATED DIETARY KEPONE ON SPOT (LEIOSTOMUS XANTH-URUS).

URUSS, Virginia Inst. of Marine Science, Gloucester Point. L. L. Stehlik, and J. V. Merriner. Aquatic Toxicology, Vol. 3, No. 4, p 345-358, May, 1983. 5 Fig, 11 Tab, 33 Ref.

Descriptors: \*Bioaccumulation, \*Diets, \*Kepone, \*Spot, Biological effects, Fish toxins, Mortality, Water pollution effects.

The water, sediments and biota of the James River, The water, sediments and biota of the James River, in Virginia, are contaminated with organochlorine pesticide Kepone (Chlordecone). Migratory fish accumulate Kepone while they reside in the James River during the summer. The administration of Kepone on Juvenile spot body burdens increased additively and equilibrium was not attained. When spot were fed a lethal concentration (3.3 micrograms/g) over 28 days, they accumulated an average of 2.7 micrograms/g (wet wt). Most developed

muscular tetany, fractured vertebral centra, and abnormally thickened vertebrae. These symptoms developed over a 4-wk period until death. Spot fed lesser concentrations (0.59 and 0.30 microgram/g) accumulated 0.7 and 0.3 microgram/g over 56 days and developed similar bone damage. The percentage of collagen in vertebrae was significantly greater in the treated fish which had thickened bones. Spot that were held in the laboratory as controls for 5 wk had significantly lower collagen percentages than wild fish. Kepone accumulation is the likely mechanism for production of the bone deformities observed in fishes from the James River in 1971-1976. (Murphy-IVI) W84-03115

RELATIVE LIVER WEIGHTS AND XENOBIO-TIC-METABOLIZING ENZYMES OF FISH FROM POLLUTED SURFACE WATERS IN

THE NETHERLANDS, Rijksinstitut voor Drinkwatervoorziening, Leids-chendam (Netherlands). Chemical Biological Div. W. Slooff, C. F. Van Kreijl, and A. J. Baars. Aquatic Toxicology, Vol. 4, No. 1, p 1-14, August, 1983. 5 Fig. 5 Tab, 24 Ref.

Descriptors: \*Liver weights, \*Xenobiotic compounds, \*Metabolizing enzymes, \*Fish toxins, \*Water pollution, \*Surface water, \*Netherlands, Chemical wastes, Bioaccumulation, Bioindicator, Biological effects, Rhine River.

Organisms inhabiting the river Rhine are exposed to a wide variety of foreign organic chemicals. From laboratory experiments it is known that exposure to xenobiotic compounds often results in liver enlargement, usually associated with the induction or stimulation of hepatic enzyme activities. The somatic liver index (SLI) values were significant to make the foreign control of the control of th cantly greater in populations sampled from con-taminated waters than in those from less polluted areas. The highest values from Rhine fish were (3.5) and the lowest for Lake Braassem fish were (1.5). Both biochemical and histological observa-(1.5). Both biochemical and histological observations suggest that the liver enlargement is mainly caused by hypertrophy. The liver growth was accompanied by elevated hepatic enzyme activities. Like most other liver parameters, the SLI showed seasonal variations with the highest values in winter and the lowest in spring. Over the past 3 years there has been a decrease of the relative liver weight of Rhine and Meuse fish in time, which may reflect the improvement of the chemical water quality of these rivers. The SLI may be useful as an indicator of chemical water pollution. (Murphy-IVI) (Murphy-IVI) W84-03116

TOXICITY OF CYANOBACTERIA IN DUTCH LAKES AND RESERVOIRS, Utrecht Rijksuniversiteit (Netherlands). Dept. of Veterinary Pharmacology, Pharmacy and Toxicol-

For primary bibliographic entry see Field 2H. W84-03117

BENTHIC MACROINVERTEBRATES AND WATER QUALITY ASSESSMENT: SOME TOXICOLOGICAL CONSIDERATIONS,

endam (Netherlands). Chemical Biological Div. Slooff. Rijksinstituut voor Drinkwatervoorzie W. Slooff. Aquatic Toxicology, Vol. 4, No. 1, p 73-82, August, 1983. 3 Tab, 35 Ref.

Descriptors: \*Benthic fauna, \*Macroinvertebrates, \*Water quality, \*Toxicity, Water quality standards, Bioindicator, Chemical wastewater.

The distribution of benthic macroinvertebrates is generally considered to be indicative for the chemical quality of surface waters. However, little is known about their tolerance to chemical pollutants. To give further information on the tolerance of macrobenthos to toxic conditions of surface water, the susceptibility of invertebrate species of different taxonomical groups (Oligochaeta, Dip-tera, Hirundinea, Isopoda, Gastropoda, Tricladida, Hydrozoa, Heteroptera, Amphipoda, Odonata, Trichoptera, Ephemeroptera, Plecoptera) to 15

chemical compounds and to a mixture of organics concentrated from river Rhine water was determined in acute toxicity tests. The tolerance of macroinvertebrate species are pollutant-specific, whereas the differences in their susceptibility to toxic conditions due to pollution by several toxicants may be negligibly small. Therefore, the reliability of using biological systems based on the macrobenthos distribution to classify surface. macrobenthos distribution to classify surface waters polluted with a variety of chemical pollut-ants should be seriously doubted. (Murphy-IVI) W84-03118

THE EFFECT OF TWO TRIAZINE HERBI-CIDES ON THE PRODUCTIVITY OF FRESH-WATER MARSH PERIPHYTON,

Manitoba Univ., Winnipeg. Dept. of Botany. L. G. Goldsborough, and G. G. C. Robinson. Aquatic Toxicology, Vol. 4, No. 2, p 95-112, September, 1983. 6 Fig, 4 Tab, 37 Ref.

Descriptors: \*Ecological effects, \*Triazines, \*Herbicides, \*Periphyton, Marsh plants, Environmental impact statement, Aquatic productivity, Simazine, Terbutryn.

ine has been widely used in lake management and fish culture for the control of undesirable macrophytic species and nuisance phytoplankton macrophytic species and nuisance phytopiankton blooms. Terbutryn has recently been demonstrated to possess stronger algicidal properties than similar levels of other triazines. The colonization of acrylic substrata by periphyton is monitored by measuring chlorophyll a accumulation and carbon assimilation rate, with varying concentrations of the aquatic herbicides simazine and terbutryn added to its eith explanation and terbutryn added to its eith explanation and terbutryn added to in-situ enclosures of marsh water. There was no change, relative to an untreated control, at 0.1 mg/ change, relative to an untreated control, at 0.1 mg/
1 simazine, with increasing inhibition (to approximately 95%) at 1.0 and 5.0 mg/l. Chlorophyll a
and carbon assimilation reduced > 90% with terbuttryn concentrations of 0.01 ml/l and higher.
With factor analysis periphytic productivity correlated with water chemistry, light availability, time
and the experimental herbicide treatment. This
suggests that herbicidal effects result from a complex interaction of several parameters rather than
herbicide concentration alone. Recovery of the
communities following decreased herbicide concentrations began within 1 wk, with growth rate
equal to or greater than the control. The longterm
impact of a single dosage of these herbicides on a
periphyton community may be minimal. (MurphyIVI)
W84-03119 W84-03119

THE MICROTOX\* AS AN ALTERNATIVE ASSAY IN THE ACUTE TOXICITY ASSESSMENT OF WATER POLLUTANTS,

Rijksinstituut voor Drinkwatervoorziening, Leidschendam (Netherlands). Chemical Biological Div. D. De Zwart, and W. Slooff.

Aquatic Toxicology, Vol. 4, No. 2, p 129-138,
September, 1983. 4 Fig, 2 Tab, 11 Ref.

Descriptors: \*Beckman Microtox Assay System, \*Bioassay, \*Toxicity, \*Pollutants, Comparison studies, Water quality control, Bioluminescence, Bacteria, Algae, Protozoans, Crustaceans, Insects, Coelenterates, Mollusks, Fishes, Amphibians.

The Beckman Microtox Assay System (MAS) is based on the production of light per unit time by living luminescent bacteria, which is a reflection of the rate at which a complex set of energy-producing reactions is operating. Standard toxicity tests usually require 48 to 96 h of testing, and take about usually require 48 to 96 h of testing, and take about 10 h of actual work including the troublesome task of breeding test organisms. The MAS produces representative data in about 0.5 h, which can be considered as a primary test to quickly determine which compounds yield certain risks for the aquatic environment. In this way the standard bioassays could be limited to those samples which warrant further analysis. Mean deviation from the mean of two duplicate tests on each of three different chemicals is found to be about 10%. For some compounds the 15-min EC values were > 10% higher than the corresponding 5-min values. The MAS yielded fairly replicable results which were

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comparable wih those obtained with the standard tests. As the MAS does not require the culturing of test organisms and takes about 5% of the actual work involved in the standard procedures, the MAS should be used as a prescreening tool in the hazard assessment of chemicals. (Murphy-IVI) W84-03120

MONITORING THE RIVERS RHINE AND MEUSE IN THE NETHERLANDS FOR TOXIC-

Rijksinstituut voor Drinkwatervoorziening, Leidschendam (Netherlands). Chemical Biological Div. W. Slooff, D. De Zwart, and J. F. J. Van De Kerkhoff

Aquatic Toxicology, Vol. 4, No. 2, p 189-198, September, 1983. 3 Fig, 2 Tab, 27 Ref.

Descriptors: \*Monitoring, \*Rhine River, \*Meuse River, \*Netherlands, \*Toxicity, Organic compounds, Bioindicators, Water quality control, Mutagenicity, Surface water.

In the rivers Rhine and Meuse hundreds of potentially hazardous chemical compounds have been identified, usually at low conentrations. Although their presence has been related to chronic effects in fish in both controlled laboratory experiments and field studies, such investigations are too time-consuming to be applicable in routine monitoring programs. Therefore, short-cut biological methods are needed for water quality control, complimentary to chemical monitoring techniques. Samples concentrated by adsorption on XAD followed by elution with acetone, proved to be at least as effective in concentrating organic toxicants from river water as liquid-liquid extraction or freeze-drying. Generally, Rhine water samples were more toxic than those of Meuse water. On one Rhine location on a weekly basis, toxicity was found to vary with the seasons by more than a factor of 12. It is best to incorporate such toxicity screening tests next to chemical analyses in surveillance programs of water quality. Additionally, the biological significance of the mutagenic activity previously observed in Rhine water concentrates in a 6-month test on P. reticulata, had no effects at concentration factors < or = to 10. There were partial effects in a 33 times greater concentration (impaired swimming performance, hypertrophy of the liver, mortality). At concentration factors > or = to 100 mortality occurred rapidly, there were no apparent tumors. The hazard resulting from the chemicals responsible for the mutagenic activity is not the production of cancers, but, if real, the reduction of the fitness of the exposed populations as a result of an increased genetic load. (Murphy-IVI)

SUBLETHAL EFFECTS OF TREATED LIQUID EFFLUENT FROM A PETROLEUM REFINERY. III. AVOIDANCE AND OTHER LOCOMOTOR RESPONSES OF RAINBOW TROUT, Department of the Environment, Dartmouth (Nova Scotia).

(Nova Scotia). G. F. Westlake, J. B. Sprague, R. J. Hines, and I. T. Brown.

Aquatic Toxicology, Vol. 4, No. 3, p 235-245, November, 1983. 2 Fig. 3 Tab, 18 Ref.

Descriptors: \*Sublethal effects, \*Treated water, \*Petroleum refinery effluent, \*Fish behavior, \*Rainbow trout, Petroleum industry, Water quality standards, Effluents.

None of the rainbow trout (Salmo gairdneri) in a chamber with side-by-side flows of clean water and 0, 1, 10, or 30% oil refinery effluent, with a steep gradient between the two flows, had statistically significant avoidance or preference behavior. Similarly, the side of entry of the effluent was not related to any differences in relative activity in the four areas. When 30% effluent was present, the general level of activity in all parts of the chamber appeared to be lower than activities for the other concentrations, but the difference was at the borderline of statistical significance (P=0.06). Behavioral response to the effluent was less important than direct physiological effects on trout previous-than direct physiological effects on trout previous-than direct physiological effects on trout previous-than activities.

of effluent had an overall 3-day LC50 of about 100% effluent. The effluent exceeded Canadian regulations in average level of ammonia, was somewhat elevated in oil-plus-grease and residue, but was well below regulatory limits for phenols and sulfides. (Murphy-IVI)

SUBLETHAL EFFECTS OF TREATED LIQUID EFFLUENT FROM A PETROLEUM REFINERY. IV. RESPIRATORY MOVEMENTS AND COUGHING OF RAINBOW TROUT,

Environmental (Nova Scotia).
G. F. Westlake, J. B. Sprague, and I. T. Brown.
Aquatic Toxicology, Vol. 4, No. 4, p 317-325,
December, 1983. 2 Fig. 1 Tab, 21 Ref.

Descriptors: \*Sublethal effects, \*Treated water, \*Petroleum refinery effluents, \*Fish behavior, \*Rainbow trout, Bioindicator, Petroleum industry, Effluents, Bioassay, Toxicity, Respiration, Water quality standards, Monitoring.

There have been many studies of lethal levels of refinery effuent to aquatic organisms, but there is almost no published work that establishes the degree of sublethal toxicity. Without such research, there is no way of predicting whether a regulatory effort is likely to produce 'safe' conditions in receiving water. Rainbow trout increased the frequency of gill irrigation in linear relation to the concentration of treated refinery effluent. Full-strength effluent resulted in a significantly higher frequency than in clean water, but 50% and lower did not, because of variation in response. Coughing rate increased sharply and was less variable. A concentration of 50% effluent caused significantly more coughs than in clean water, while 25% did not. The eight samples of effluent caused little lethality at full strength, and average physico-chemical characteristics were near or below Canadian regulatory limits, except for elevated oil and grease. Coughing rate shows promise as a rapid initial method for sublethal screening or monitoring of refinery effluents. (Murphy-IVI)

SUBLETHAL EFFECTS OF TREATED LIQUID EFFLUENT FROM A PETROLEUM REFINERY. V. REPRODUCTION OF DAPHNIA PULEX AND OVERALL EVALUATION,

Environmental Protection Service, Dartmouth (Nova Scotia).

(Nova Scona). G. F. Westlake, J. B. Sprague, and D. W. Rowe. Aquatic Toxicology, Vol. 4, No. 4, p 327-339, December, 1983. 3 Fig, 2 Tab, 29 Ref.

Descriptors: \*Sublethal effects, \*Treated water, \*Petroleum refinery effluent, \*Population dynamics, \*Daphnia, Comparison studies, Evaluation, Population exposure, Bioindicator, Bioassay, Toxicity, Reproduction, Monitoring, Water quality standards, Effluents, Oil refineries.

Despite the worldwide occurrence of oil refineries, and much concern about regulating their discharges into surface waters, there is almost no research on sublethal effects of a real refinery effluent on aquatic organisms. The 48-h LC50 of treated refinery effluent for 2-day-old Daphnia pulex was 76% effluent. The 14-day LC50 was 6.4% effluent and this was a threshold value for mortality. For reproductive failure, the 14-day EC50 was 3.1% effluent, and the EC5 of 0.52% effluent was considered to approximate the threshold of sublethal effect. Daphnia reproduction was the most sensitive response in a series of studies that included fish growth, reproduction, locomotion, and respiration. Results are considered representative for a well-treated effluent from a petroleum refinery. The 48-h lethal test with D. pulex would be a useful tool for monitoring or assessing such effluents, since it is simple, small-scale, quick, and about 2.6 times as sensitive as a lethal test with trout. (Murphy-IVI)

OVERLAP AND POLLUTION-INDUCED VARIABILITY IN THE FEEDING HABITS OF FI-

LEFISH (PISCES: MONACANTHIDAE) FROM APALACHEE BAY, FLORIDA,

Florida State Univ., Tallahassee. Dept. of Biological Science.

W. H. Clements, and R. J. Livingston. Copeia, No. 2, p 331-338, May, 1983. 5 Fig, 3 Tab, 40 Ref. EPA grant R-805288010.

Descriptors: \*Water pollution effects, \*Fish behavior, \*Variability, \*Filefish, \*Apalachee Bay, \*Florida, Estuaries, Estuarine fisheries, Spatial distribution, Temporal distribution, Pulp wastes, Ecological effects.

The impact of pollution on feeding habits and trophic structure is not well known. Changes in the distribution and abundance of prey resulting from disturbances will often be refleted in a predactor's diet. The spatial and temporal distribution and feeding habits of two species of filefish, Monacanthus ciliatus and Stephanolepis hispidus, overlap broadly. An apparent similarity in diet reduced when prey were identified to species. Ontogenetic variation of each species had a tendency toward herbivory with increasing standard length. The feeding habits of Mc. ciliatus taken from areas affected by pulp mill effluents were different than those from a nearby unpolluted estuary. Cluster analysis of stations within the two systems, based on feeding habits of Mc. ciliatus, were similar to those based on numbers of fishes and macrophyte biomass. Differences in the feeding habits between the two systems may be due to pollution-induced habitat modifications and resulting changes in prey distribution. This may represent an additional method of assessing the effects of pollution. (Murphy-IVI) W84-03132

ECOLOGY OF PLANKTONIC LARVAE OF DREISSENA POLYMORPHA (PALL.) IN LAKES WITH DIFFERENT DEGREE OF HEATING,

Polish Academy of Sciences, Krakow. Zaklad Biologii Wod.

K. Lewandowski, and J. Ejsmont-Karabin. Polskie Archiwum Hydrobiologii, Vol. 30, No. 2, p 89-101, 1983. 7 Fig, 4 Tab, 28 Ref.

Descriptors: \*Ecology, \*Larvae, \*Dreissena, \*Thermal pollution, Epilimnion, Thermal stratification, Powerplants, Cooling water, Thermocline, Mollusks, Mortality, Poland.

The heating of waters in natural water bodies is an effect of the operation of electric power stations which use the water for cooling purposes. The Konin Lakes complex (Poland), heated by Konin and Patnow power stations, is an example of altered ecosystems. The power stations have a problem with mass invasions of Dreissena polymorpha. The planktonic larvae of D. polymorpha were studied during six seasons (1970-1970) in six lakes included in the cooling systems of the electric power stations. They were encountered from April until September, with an earlier appearance by two months in heated lakes than in unheated lakes of the same climatic zone. Most of the larvae (90%) were in the epilimnion of the lakes except for near the discharge of cooling waters to Slesinskie Lake where larvae were abundant in the whole water column. The youngest larvae were most abundant in shallow layers, the older ones in the deeper zone. There were considerable numbers of deal larvae (up to 20 individuals per cu dm) in the studied lakes. There is a high mortality rate due to the heating of the lakes. (Murphy-IVI)

ECOLOGICAL CHARACTERISTICS OF POLI-SAPROBIC SECTION OF THE VISTULA RIVER BELOW WARSAW,

Polish Academy of Sciences, Warsaw. Inst. of Ecology.

M. Kaniewska-Prus. Polskie Archwum Hydrobiologii, Vol. 30, No. 2, p 149-163, 1983. 9 Fig, 3 Tab, 23 Ref.

Descriptors: \*Water pollution effects, \*Vistula, \*Poland, Benthos, Water quality, Seasonal varia-

### Effects Of Pollution—Group 5C

tion, Dissolved oxygen, Nitrogen, Phosphates, Oli-gochaetes, Diptera, Biomass, Eutrophication, gochaetes, Diptera, Wastewater pollution.

In 1980-81 studies were carried out on chemical changes in water, and numbers and biomass of macrobenthos in the Vistula river (Poland) at varimacrobenthos in the Vistula river (Poland) at various distances from the pollution source (municipal sewage). From chemical analyses the quality of water was estimated by qualitonomic method. Along a section of 25 km in length from the source of pollution the quality of water does not undergo considerable changes. At all four site the water possessed a high oxygen saturation. The concentration of chlorides was also high at all sites. Inorganic nitrogen and phosphate concentrations were highest at the site nearest the pollution source and lowest at the site farthest from it. The water quality, depending on the season, is either very bad, or lowest at the site farthest from it. The water quality, depending on the season, is either very bad, or bad; only sporadically is it of average level. Among benthic animals Oligochaeta are clearly predominant. Tendipedidae were regularly observed and other dipteran larvae were observed sporadically. Both numbers and biomass of benthos varied considerably depending on the season and water quality. The indices of water pollution, as based on numbers and biomass of taxonomic groups of benthic animals have corroborated the high degree of pollution in this section of the river. (Moore-IVI)

OXYGEN CONSUMPTION AND SURVIVAL OF ASELLUS AQUATICUS L. (CRUSTACEA) IN VISTULA RIVER SECTION HIGHLY POL-LUTED BY MUNICIPAL SEWAGE.

Polish Academy of Sciences,

Ecology.
D. Zimakowska-Gnoinska.
Polskie Archiwum Hydrobiologii, Vol. 30, No. 2, p 165-173, 1983. 4 Fig, 1 Tab, 15 Ref.

Descriptors: \*Water pollution effects, \*Asellus, \*Vistula, \*Poland, Municipal wastewater, Wastewater pollution, Oxygen consumption, Mortality, Crustaceans, Respiratory rate.

The impact of polluted water was determined on oxygen consumption and survival of males of Asel-lus aquatticus L. in the period March-November 1981. The water was collected from foursites on 1981. The water was collected from foursites on the Vistula river, in the 25 km section from Bielany sewage collector output to Dziekanow Polski, which is polluted by Warsaw (Poland) municipal sewage. Measurements of respiratory rate were carried out in volumetric respirometers directly after placing animals in the polluted water, and after 24 hr of exposure to the water. Vistula river water has an unfavorable and irreversible effect on and a quarticus causing augmented respiration and water has an unavorance and intervension effect of a delayed mortality. Experimental animals after exposure to this water for 3 or 24 hours were transferred to a pure environment. Higher mortality was observed in the next 8 months. The differences from the controls were greatest in the group of animals which had been exposed to the most pol-luted water. (Moore-IVI) W84-03155

THE COREGONES OF LAKE NEUCHATEL: FISHERY YIELD; AGE AND GROWTH OF IN-DIVIDUALS CAUGHT BY PROFESSIONAL FISHERMEN (LES COREGONES DU LAC DE NEUCHATEL: RENDEMENT DE LA PECHE; AGE ET CROISSANCE DES INDIVIDUS CAP-TURES PAR LES PECHEURS PROFESSION-

Inspection Cantonale de la Chasse et de la Peche, Neuchatel (Switzerland).

J. C. Pedroli. Schweizerische Zeitschrift fur Hydrologie, Vol. 45, No. 1, p 345-358, 1983. 5 Fig, 1 Tab, 10 Ref, 1

Descriptors: \*Eutrophication, \*Coregonus, \*Lake Neuchatel, \*Switzerland, Growth, Lake fisheries, Commercial fishing, Fish populations.

The fishery of the indigenous Coregonus sp. (whitefish) of Lake Neuchatel (Switzerland) was studied using statistics kept since 1917 and data on

length, weight, and age for fish caught at random in 1927-30, 1947/48, and 1978-80. Although the total numbers and weight of C. fera (a fast growing species) are more or less constant, those of C. total numbers and weight of the tera (a last growing species) are more or less constant, those of C. macrophthalmus (a slow growing species) have diminished by 75%. Compared to other large lakes in Switzerland, the whitefish catch in Lake Neuin Switzerland, the Whitelish catch in Lake Neu-chatel has been abnormally low for the last 20 yr. A decrease in the number of whitefish and eutro-phication of the lake are two factors which have lowered the mean age of the fish and accelerated their growth rate. For 1978-80, the lengths of the fish are more uniform, and the two types are more fish are more uniform, and the two types are more difficult to distinguish. This may be due to hybridization, but it is more likely that the frequency of lengths per age class are more uniform. (Moore-IVI)

W84-03176

DECLINE OF RED SPRUCE IN THE NORTH-ERN APPALACHIANS: ASSESSING THE POS-SIBLE ROLE OF ACID DEPOSITION,

Pennsylvania Univ., Philadelphia. A. H. Johnson, and T. G. Siccama. Tappi Journal, Vol. 67, No. 1, p 68-72, January, 1984. 6 Fig. 31 Ref.

Descriptors: \*Spruce, \*Acid deposition, \*Acid rain, \*Appalachian Mountains, Forests, Clouds, Acid mists, Heavy metals, Aluminum, Metals, Plant pathology, Drought, High elevations, Water

High-elevation spruce-fir forests of the eastern U.S. receive particularly high rates of acidic deposition (up to 4 keq of H(+)/ha/yr), vegatation is exposed to highly acidic cloud moisture for up to 2000 h/yr, and very high levels of trace metals have accumulated. Red spruce (Picea rubens) in the northern Appalachians have died in abnormally large numbers over the past two decades without obvious cause. Considerable attention has been focused on the possible role of acid deposition in the decline. Because of the documented accumulation of heavy metals, the high rates of acidic deposition, the prolonged contact with acidic mist, and laboratory evidence that reasonable levels of and laboratory evidence that reasonable levels of and laboratory evidence that reasonable levels of dissolved aluminum and possibly other metals can alter water movement in red spruce, anthropogenic pollutants may be involved in the red spruce decline. Widespread reports of spruce mortality in the last century following a series of dry summers suggest the possibility that spruce decline could occur in the absence of high levels of acid or metal denoisition. (Moore, IVI) deposition. (Moore-IVI) W84-03191

GROWTH OF SALVINIA MOLESTA AS AF-FECTED BY WATER TEMPERATURE AND NUTRITION; II. EFFECTS OF PHOSPHORUS

Commonwealth Scientific and Industrial Research Organization, Griffith (Australia). Div. of Irrigation Research

P. R. Cary, and P. G. J. Weerts. Aquatic Botany, Vol. 17, No. 1, p 61-70, September, 1983. 4 Tab, 9 Ref.

Descriptors: \*Salvinia, \*Aquatic weeds, \*Temperature effects, \*Phosphorus, \*Nutrient removal, Nutrients, Water temperature, Growth, Biological

Salvinia molesta is a free-floating aquatic plant that is native to South America, but is now widely distributed throughout the tropics. The growth of S. molesta, as affected by phosphorus supply and water temperature, was studied in a greenhouse using controlled water temperature baths at 16, 19 and 22 C. For significant responses to the phosphorus treatments to be obtained it was necessary to the phosphorus treatments to be obtained it was necessary to the phosphorus treatments to be obtained it was necessary to use P-deficient plant propagales (containing < 0.01% P on a dry matter basis). For these plants the highest relative growth rate and dry matter production occurred at 22 C when they received 10.01 mg PO4-P/l, but this was not significantly different from that of plants receiving 1.01 mg PO4-P/I. Over a period of 21 days for plants receiving 0.02 mg PO4-P/I the biomass increased 4-fold at 19 C and 6-fold at 22 C. In contrast, for plants receiving 10.01 mg PO4-P/I biomass was increased 20-fold at 19 C and 32-fold at 22 C. At the latter temperature, when receiving 60.06 mg PO4-P/I, plants concentrated up to 1.3% of phos-phorus on a dry matter basis, suggesting a possible use as a biological filter and purifier of contaminat-ed waters. Water authorities should maintain nutrients below minimum critical levels to prevent ex-plosive growth of this notorious weed. (Moore-W84-03192

A STUDY ON THE GROWTH OF SALVINIA MOLESTA MITCHELL IN RELATION TO LIGHT AND TEMPERATURE,

Kurukshetra Univ. (India). Dept. of Botany. V. Usha Rani, and S. Bhambie. Aquatic Botany, Vol. 17, No. 2, p 119-124, October, 1983. 2 Fig. 1 Tab, 12 Ref.

Descriptors: \*Aquatic weeds, \*Salvinia, \*Solar radiation, \*Temperature effects, \*Growth, Seasonal variation, Water quality.

Salvinia molesta is a free-floating weed in most of the Indian inland freshwater systems. It adversely affects water quality, decreases aesthetic values and creates problems for rice growers. The effects of light intensity and temperature on the growth of S. molesta were studied under shade and full sunlight conditions. Growth, in terms of increase in fresh weight and number of offshoots produced was significantly different (P<0.001) under the two light conditions; it was highest under shad during May-July, and in August-September under full sunlight. From November to March, under both light conditions, growth was reduced and was minimal from December to February in shade and from December to January in full sunlight. Mean relative growth rate (RGR) varied from 0.01 to 0.07 g/g/day. Increase in the fresh weight had a significant positive non-linear relationship with augmicant positive non-linear relationship with light intensity and atmospheric temperature. How-ever, since there was a significant positive relation-ship between temperature and light intensity, it was not possible to separate their effects through regression analysis. (Moore-IVI)

IMPACT OF ACIDIFICATION AND EUTRO-PHICATION ON MACROPHYTE COMMUNI-TIES IN SOFT WATERS IN THE NETHER-LANDS, I, FIELD OBSERVATIONS,

Katholieke Univ., Nijmegen (Netherlands). Lab. of Aquatic Ecology.

For primary bibliographic entry see Field 2H.

CHARD AS INDICATORS OF POLLUTION Staatliches Inst. fuer Seenforschung und Fischer-eiwesen, Langenargen (Germany, F.R.). J. Hartmann. Fisheries, Vol. 8, No. 6, p 10-12, November-December, 1983. 1 Fig, 19 Ref.

Descriptors: \*Charr, \*Bioindicators, \*Pollutant identification, Lake Constance, Eutrophication, Hydrocarbons, Heavy metals, Chironomids, Turbellarians, Tubificids.

Lake Constance forms a border between Austria, Switzerland, and West Germany. The lake has been subject to eutrophication in recent decades. Chironomids and turbellarians are two of the three main components of the charr's diet in the lake and these organisms may also be useful as biological indicators. The horizontal distribution of the charr in Lake Constance before and after cultural eutro-phication is quite different. Areas where charr are phication is quite different. Areas where charr are still caught in large numbers today support few tubificids but many chironomids. These habitats are distant from the major towns and sites of affluent waters and sediments and are not severely polluted by hydrocarbons or heavy metals. The distribution of the charr has progressively been constrained to the least disturbed areas of the lake.

### Field 5-WATER QUALITY MANAGEMENT AND PROTECTION

### **Group 5C—Effects Of Pollution**

FERTILIZER AND SALTY WATER EFFECTS ON PHASEOLUS

Cornell Univ. Agricultural Experiment Station Ithaca, NY. Dept. of Agronomy. For primary bibliographic entry see Field 3C. W84-03239

THE MACROINVERTEBRATE FAUNA OF THE DRAINAGE CHANNELS OF THE GWENT LEVELS, SOUTH WALES,

LEVELS, SOUTH WALES, University of Wales Inst. of Science and Technology, Cardiff. Dept. of Applied Biology. P. Clare, and R. W. Edwards. Freshwater Biology, Vol. 13, No. 3, p 205-225, June, 1983. 7 Fig. 10 Tab, 42 Ref.

Descriptors: \*Macroinvertibrates, \*Drainage channels, \*Gwent Levels, \*South Wales, Benthic fauna, Oxygen balance.

From a survey of the fauna at sixty sites in permanent drainage channels of the Gwent Levels during the spring of 1976 and at some of these site (thirty-three) during the autumn, species and site associations were identified using classification and ordination techniques. Sites in some groups had identifiably similar environmental characteristics and grouping seemed particularly related to the vegetational stage in the hydrosere, water flow and the incidence of salt contamination from the Severn Estuary. Characteristics which were common within particular species groups and which, in part, explained their distributions were adaptation to low oxygen concentrations, food which, in part, explained their distributions were:
adaptation to low oxygen concentrations, food
preferences and dispersal mechanisms. Whilst there
was some temporal stability in site groups between
the spring and autumn surveys, such associations
were not identical. The oxygen status of channels
appeared a major factor determining faunal distributton. Twelve sites, representing a range of chanbution. Twelve sites, representing a range of chan-nel types, were sampled six times in a 12-month period. Far more species were collected within the period. Far more species were collected within the water column and on plants than in the benthos. Several oligochaetes, e.g. Aulodrilus pluriseta, Dero digitata, Limnodrilus claparedeanus, were not recorded at most sites during the summer probably because of the sustained lack of oxygen at these sites. Three contiguous reaches of channel were maintained during the period March-October 1977, with different also sources on Lemocropes. were maintained during the period March-October 1977 with different plant cover (no Lemna; complete Lemna cover; control with partial Lemna cover). The oxygen status of the reaches was different, that with complete Lemna cover being continuously anaerobic near the channel bed for several months, the control reach which had partial Lemna cover being anaerobic for a shorter period and that with no Lemna being only anaero-bic at night. Whilst the distribution of macroinvertebrate species was principally related to this oxygen status, the control reach which was structrally the most complex, having both submerged and floating plants, contained about twice as many species as the other reaches during the summer collected in the water column and on plants): benthic samples in this and the reach with complete Lemna cover contained only between zero and two species during the period May-September. (Author's abstract)

A MODEL RELATING THE RESULTS OF LOW PH BIOASSAY EXPERIMENTS TO THE FISHERY STATUS OF NORWEGIAN LAKES, Central Electricity Generating Board, Ratcliffe-on-Soar (England). Ratcliffe-on-Soar Power Station. K. Sadler.

Freshwater Biology, Vol. 13, No. 5, p 453-463, October, 1983. 5 Fig, 2 Tab, 51 Ref.

Descriptors: \*Model studies, \*Hydrogen ion con-centration, \*Bioassay, \*Fisheries, \*Lakes, \*Norway, Water pollution sources, Fate of pollut-ants, Water quality, Water pollution effects, Trout, Mortality, England.

The acidification of waters has been linked with the loss of fish populations. One of the best studied regions which has been the subject of much con-cern is Sorlandet (southernmost Norway). Leslie matrices using data from the literature concerning serveral Norwegian brown trout (Salmo trutta)

populations estimates their capacity to withstand egg and fry mortalities. These estimates compared with the results of bioassay studies conducted at pH 4.5 and at various calcium concentrations predicts the percentage of trout populations which would be able to survive these conditions. These would be able to survive these conditions. I ness predictions are in good agreement with the observed fishery status of Norwegian lakes at calcium concentrations <30 microeq/l but above this concentration the recorded status is worse than predicted. Likely causes for this difference are considered to be effects acting on fish older than those used in the bioassay experiments (either mortality used in the bioassay experiments (either mortality or reduction in fecundity possibly due to impaired growth) or the effects of other water quality factors, for example aluminium. These effects need only be fairly slow acting as compared with the egg and fry mortalities so far studied in detail. Thus the discrepancy between predicted and observed results at pH 4.5 and 50 microeq/l calcium could be caused by an additional 80% mortality acting over the 4-8 year period before maturation. An additional factor which could result in the observed fishery status being worse than predicted is temporal variation in water chemistry which is is temporal variation in water chemistry which is not assessed in the survey of Norwegian lakes. In particular, the adverse conditions occurring at time of snowmelt could be critically important. of snowmelt (Murphy-IVI) W84-03298

PRIMARY PRODUCTIVITY STUDIES DURING EARLY YEARS OF WEST POINT RESERVOIR, ALABAMA-GEORGIA, Auburn Univ., AL. Dept. of Fisheries and Allied

Aquacultures

D. R. Bayne, J. M. Lawrence, and J. A. McGuire. Freshwater Biology, Vol. 13, No. 5, p 477-489, October, 1983. 4 Fig, 3 Tab, 36 Ref.

Descriptors: \*Primary productivity, \*West Point Reservoir, \*Alabama, \*Georgia, Phytoplankton, Fish populations, Population dynamics, Eutrophication, Hydrogen ion concentration, Water quality, Water pollution effects, Water pollution sources, Fate of pollutants.

Phytoplankton density (organisms/ml), standing crop (chlorophyll a mg/sq m) and primary productivity (mg C/m/d) were measured during years 2 (1976) to 5 (1979) after impoundment on West Point Lake. West Point waters had low alkalinity (<0.4 meq./l) and low conductivity (<75 micros) cm at 20 degrees C) but N and P concentrations typically exceeded those considered apt to cause muisance blooms of algae. Abiogenic turbidity was normally higher in the upstream areas of the reservoir than in the downstream areas and was several voir than in the downstream areas and was several times higher in winter-spring than in summer-autumn due to increased rains and runoff. Primary productivity varied greatly both temporally and spatially. A mean value of 684 mg C/m/d was well spatially. A mean value of 884 mg C/m/d was well within the mesotrophic range and did not approach the highly eutrophic state predicted. Productivity increased from a low of 550 mg C/m/d in 1976 to high of 763 mg C/m/d in 1979. Observed variation in both chlorophyll a and primary productivity was more predictable in the cool (December-March) than in the warm (June-Septemcember-March) than in the warm (June-September) season and with plant nutrient data than without it. With plant nutrient data in the cool season 84% and 86% of the variation (R2) in chlorophyll a and productivity, respectively, were accounted for by the regression equations. During the warm season, with plant nutrient data, regression equations accounted for 44% and 68% of the variation in chlorophyll a and productivity, respectively. Higher R2 values in cool seasons resulted from the overriding influence of abiogenic turbidity on phy-toplankton communities. (Author's abstract)

COMMUNITY STRUCTURE IN SOME SOUTHERN ENGLISH STREAMS: THE IN-FLUENCE OF PHYSICOCHEMICAL FAC-

University of East Anglia, Norwich (England). School of Biological Sciences. C. R. Townsend, A. G. Hildrew, and J. Francis.

Freshwater Biology, Vol. 13, No. 6, p 521-544, December, 1983. 8 Fig, 3 Tab, 57 Ref.

Descriptors: \*Community development, \*England, \*Streams, \*Physiochemical properties, Hydrogen ion concentration, Water pollution effects, Water pollution sources, Biological properties, Population dynamics, Aquatic fauna.

Low pH and high iron concentration are factors of growing concern to aquatic ecologists. Acidification of surface waters by polluted rainfall is wide-spread and acute and acid waters always seem impoverished in comparison with systems which are more basic but otherwise similar. Invertebrates and fish were surveyed during October 1976 in thirty-four stony riffle stream sites in Ashdown Forest, Sussex. A variety of physicochemical factors were also measured in an attempt to assess the importance of each in determining the distribution of species and the structure of communities. Three Low pH and high iron concentration are factors of of species and the structure of communities. Three analytical techniques - stepwise multiple regression analysis, ordination and community classification revealed that the structure of these communities was strongly related to variation in stream pH. Acid sites had low numbers of individuals, low species richness and low equitabilities. Summer temperature and stream discharge also appeared to play significant roles. The pattern of catchment land use has an important bearing on stream pH. In the most acid sites only collectors, shredders and predators occurred. In more basic sites the number of species in collector and predator categories and filter feeders. A theoretical basis for explaining stream community structure is discussed. (Murphy-IVI) of species and the structure of communities. Three

W84-03300

CONCENTRATIONS OF TOTAL DISSOLVED SOLIDS PREFERRED OR AVOIDED BY EN-DANGERED COLORADO RIVER FISHES,

Utah Cooperative Fishery Research Unit, Logan

R. Pimentel, and R. V. Bulkley. Transactions of the American Fisheries Society, Vol. 112, No. 5, p 595-600, September, 1983. 1 Fig. 3 Tab, 20 Ref.

Descriptors: \*Concentrations, \*Total dissolved solids, \*Fish behavior, \*Endangered species, \*Colorado River, Dissolved solids, Environmental effects, Squawfish, Humpback chub, Bonytail, Water pollution effects. \*Concentrations, \*Total dissolved

Juveniles of three endangered Colorado River fishes were subjected to a gradient of total dis-solved solids (TDS) to determine the concentrasolved solids (TDS) to determine the concentrations that they preferred or avoided. Preferred and avoided TDS concentrations, respectively, for juveniles of Colorado squawfish were 560-1,150 mg/l and greater than 4,400 mg/l, for humpback chub 1,000-2,500 mg/l and greater than 5,100 mg/l, and for bonytail 4,100-4,700 mg/l and less than 560 mg/l or greater than 6,600 mg/l. Colorado squawfish and humpback chubs selected TDS concentrations that were similar to those in waters they now inhabit, but honytails selected concentrations four tions that were similar to those in waters they now inhabit, but bonytails selected concentrations four times higher. Future increases of TDS in the Colorado River system would degrade municipal, industrial, and agricultural water used before these endangered fishes would be affected. (Murphy-IVD) IVI) W84-03314

TEMPERATURE PREFERENCE AND AVOID-ANCE BY ADULT RAZORBACK SUCKERS,

Utah Cooperative Fishery Research Unit, Logan. R. V. Bulkley, and R. Pimentel. Transactions of the American Fisheries Society, Vol. 112, No. 5, p 601-607, September, 1983. 1 Fig,

Descriptors: \*Temperature, \*Fish behavior, Suckers, Temperature effects, behavior, Colorado River, Fish conservation, Fish management, Envi-ronmental effects, Dam effects.

Final thermal preferendum for the razorback sucker (Xyrauchen texanus), a rare endemic species of the Colorado River basin, was between 22.9 and 24.8 C based on electronic-shuttlebox studies. Upper and lower avoidance temperature ranged from 27.4 to 31.6 C and from 8.0 to 14.7 C,

### Effects Of Pollution-Group 5C

respectively. Lower, but not upper, avoidance temperature was positively correlated with acclimation temperature. The lower aviodance temperature and thermal preferenda support the theory that temperature change was involved in the disappearance of razorback suckers and three other native endangered species form the tailwaters of Flaming Gorge Reservoir on the Green River, Utah. New water-control structures on the upper Colorado River drainages should be designed to Colorado River drainage should be designed to provide summer water temperatures between 22 and 25 C if preservation of habitat for this species is a consideration. (Murphy-IVI) W84-03315

MORTALITY OF WALLEYE EGGS AND RAIN-BOW TROUT YOLK-SAC LARVAE IN LOW-PH WATERS OF THE LACLOCHE MOUN-TAIN AREA, ONTARIO,

Trent Univ., Peterborough (Ontario). Dept. of Biology. For primary bibliographic entry see Field 2H. W84-03316

ALTERATIONS IN GILL EPITHELIAL MOR-PHOLOGY OF YEARLING SUNAPEE TROUT EXPOSED TO ACUTE ACID STRESS,

Maine Cooperative Wildlife Research Unit, Orono. C. H. Jagoe, and T. A. Haines.
Transactions of the American Fisheries Society, Vol. 112, No. 5, p 689-695, September, 1983. 3 Fig, 2 Tab, 36 Ref.

Descriptors: \*Fish, \*Acidity, \*Water pollution effects, Trout, Acid rain, Mortality, Maine, Hydrogen ion concentration.

Gill filaments of hatchery-reared yearling Sunapee trout Salvelinus alpinus oquassa that had been ex-posed to acute acid stress in static water bioassays were examined by scanning electron microscopy. Fish exposed to acidified water at pH levels above those that caused acute mortality showed little those that caused acute mortality showed little alteration in gill morphology. Exposure to acutely lethal levels of acidity caused considerable damage to gill epithelia, including primary lamellar swelling, increasingly rugose secondary lamellar surfaces, increased mucus production, and fusion of adjacent secondary lamellae. The loss of microridge patterns on the epithelia of the secondary lamellae became more severe with decreasing pH. Such changes may decrease the surface area avaisable. Such changes may decrease the surface area avaiabefor gas exchange and contribute to the anoxia that appears to be an important source of mortality in very low pH levels. (Baker-IVI) W84-03317

### ACUTE TOXCITY OF AMMONIA TO RAIN. BOW TROUT, Montana State Univ., Bozeman, Fisheries Bioassay

R. V. Thurston, and R. C. Russo.

Transactions of the American Fisheries Society, Vol. 112, No. 5, p 696-704, September, 1983. 1 Fig, 5 Tab, 15 Ref. EPA grants R800861, R803950 and

Descriptors: \*Ammonia, \*Trout, Fish, Toxicity, Water pollution effects, Acclimatization, Dissolved oxygen.

The acute toxicity of ammonia to hatchery-reared rainbow trout was measured in 86 flow-through tests, ranging from 96 hours to 35 days in length. Fish ranged in age from 1 day old fry to 4 yr old adults. The 96 hour median lethal concentrations ranged from 0.16 to 1.1 mg/liter unionized ammoranged from 0.16 to 1.1 mg/ltter unionized ammonia. Susceptibility to ammonia decreased as the fish developed from sac fry to juveniles, and increased thereafter. Acute toxicity decreased as temperature increased over the range 12 to 19 degrees C. No significant differences in toxicity were observed in tests with different ammonium salts including amtiess with different ammonium saits including ammonium chloride, ammonium iscarbonate, ammonium phosphate and ammonium sulfate. The LC50 values obtained for 12- and 35-day tests were not appreciably different from those obtained for tests of shorter time periods. (Baker-IVI)

CHRONIC EFFECTS OF COAL-LIQUID DIS-PERSIONS ON FATHEAD MINNOWS AND RAINBOW TROUT,

Battelle Pacific Northwest Labs., Richland, WA. Environmental Sciences Dept.
D. D. Dauble, S. A. Barraclough, R. M. Bean, and

V. E. Fallon.

Transactions of the American Fisheries Society,
Vol. 112, No. 5, p 712-719, September, 1983. 1 Fig.

Tab, 16 Ref. USDE contract DEAC06-76RLO

Descriptors: \*Fish, \*Water pollution effects, \*Phenols, Coal-liquification, Trout, Minnows, Mortality, Toxicity, Organic compounds, Bioassay.

Fathead minnows and rainbow trout were used in Fathead minnows and rainbow trout were used in partial-life-cycle bioassays under continuous-flow regimes, with water soluble fractions (WSFs) derived from a coal liquid. Phenols constituted 95% of the organic carbon in stock WSFs. Growth of larval fathead minnows was significantly reduced at 0.25 mg/liter total phenols as determind by dye photometry. At 1.27 mg/liter total phenols, spawning of adult fathead minnows was inhibited and was significantly reduced at 0.62 mg/liter total phenols. Sexuming inhibition was not permanental stablengles. was significantly reduced at 0.02 ing/mer total phenols. Spawning inhibition was not permanent at these concentrations. Fathead minnow pairs re-sumed spawning 21 days after transfer to control water. The minimal concentration of WSFs that caused significant mortality to rainbow trout de-pended on the length of time exposed. A 14 day exposure to concentrations equal to or greater than 2.98 mg/liter total phenols was fatal to all rainbow trout embryos due to either egg mortality or premature hatching. Rapid mortality was noted in swim-up rainbow trout after 28 days exposure to swim-up rainbow trout after 28 days exposure to 0.13 mg/liter total phenols. Death was partially attributed to clogging of the gills by fungal growth. Possible changes in the composition of water-soluble components occur due to chemical and biological degradation, making long term toxic effects of complex organic mixtures difficult to predict based on dilution of known constituents. (Baker-IVI)

# PHENOL TOLERANCE IN POPULATIONS OF MOSQUITOFISH FROM POLLUTED AND NONPOLLUTED WATERS,

ma Univ. in Birmingham. Dept. of Biology. R. A. Angus.
Transactions of the American Fisheries Society,
Vol. 112, No. 6, p 794-799, November, 1983. 2

Descriptors: \*Fish behavior, \*Phenols, pollution effects, Organic compounds, Mosquito-fish, Fish, Mortality, Industrial wastes, Lake Purdy, Valley Creek, Alabama.

Fish populations in polluted streams, if not driven to local extinction, may adapt to certain toxic substances over time. Adaptation may involve physiological acclimation if previous exposure has led to the induction of detoxification enzyme sysled to the induction of detoxification enzyme sys-tems. The phenol tolerances of three Alabama populations of mosquitofish were compared. Two of the populations lived in industrially polluted streams and one in a nonpolluted lake. The 48 hour phenol LC50 was significantly higher for mosqui-tofish from Valley Creek, below the point where tofish from Valley Creek, below the point where the creek receives coke-treatment wastewater from a steel plant, than for populations from Village Creek or the unpolluted Lake Purdy, The 8-hour tests confirmed the existence of resistant and susceptible phenotypes in the Valley Creek and Lake Purdy populations. Both populations contained fish of resistant and susceptible phenotypes. The difference was in their relative frequencies. In Valley Creek, 67-80% of the fish were resistant whereas in Lake Purdy, only 23-27% of the fish were resist-Lake Purdy, only 23-27% of the fish were resistant. An 8-hour toxicity test with 1 mg/liter potassium cyanide showed no discrete categories of sus-ceptible or resistant fish. Mortality occurred throughout the test and a majority of fish died in the middle 4 hours. (Baker-IVI) W84-03322

WATERBORNE DISEASE OUTBREAKS - 1946-80: A THIRTY-FIVE-YEAR PERSPECTIVE,

Breidenbach Environmental Research Center, Cincinnati, OH.

E. C. Lippy, and S. C. Waltrip.

Journal American Water Works Association, p 60-67, February, 1984. 16 Fig, 5 Tab, 8 Ref.

Descriptors: \*Human diseases, Disinfection, Water supply, Water quality control, Microorganisms, Public health, Pathogenesis.

The 672 outbreaks of waterborne disease that were reported in the United States between 1946 and 1980 affected more than 150,000 persons. An analysis of the data from these oubreaks provides information on how often and where they occurred, as mation on how often and where they occurred, as well as on what caused them. Using just the data from 1976-1980, when reporting was greatly improved, the average annual frequency of outbreaks was 38. Clustering was evident when outbreaks in community systems were geographically distributed and rate-based according to the number of water systems in a respective state. Outbreaks exhibit temporal distribution, with peak occurrences in June, July, and August. Although outbreaks in noncommunity systems outpumber those in comnoncommunity systems outnumber those in com-munity systems, the frequency of outbreaks in almost twice as great in community systems. Cases of illness occurring in community water systems far outnumber those in noncommunity systems. Regulatory agencies should concentrate their efforts on protecting the source of water supply. Microbial agents that cause waterborne outbreaks are rarely isolated from the water system. The are rarely isolated from the water system. Incedeficiences in water systems that caused and contributed to waterborne outbreaks during this 35 year period differed little from those reported for the previous 26 years. The glaring deficiencies were that disinfection was not in place where it was needed and not properly operated where it was in place. (Baker-IVI) W84-03368

THE INFLUENCES OF TEMPERATURE VARI-ATIONS AND THERMAL POLLUTION ON VARIOUS ASPECTS OF THE BIOLOGY OF THE PRAWN PALAEMON PACIFICUS (STIMPSON),

Cape Town Univ. (South Africa). Dept. of Zoolo-

gy. Y. Achituv, and P. A. Cook.

Journal of Experimental Marine Biology and Ecology, Vol. 74, No. 3, p 291-302, January, 1984. 3 Fig, 8 Tab, 15 Ref.

Descriptors: \*Temperature effects, \*Thermal pol-lution, \*Prawn, \*Palaemon pacificus, \*Stimpson, Thermal stress, Growth, Growth kinetics, Juvenile growth stage, Growth stages, Fish behavior.

The influence of different temperatures 10, 15, 20, and 25 degrees Centigrade on the food con tion, growth, moulting rate, and respiration of Pa-laemon pacificus (Stimpson) from Langebaan Lagoon, west coast of South Africa, under laboratory conditions, produced a high mortality rate at 10 degrees C. At higher temperatures, food consumption was found to be temperature dependent, the rate at 25 degrees C being twice that at 15 degrees C. Growth rate was most favorable at 25 degrees C. Growth rate was most favorable at 25 degrees C. At 28 degrees C growth rate was lower than at 20 degrees C but higher than at 15 degrees C. The intermoult period was 17 days at 15 degrees C, and 11 and 10 days at 20, and 25 degrees C, respectively. There are several indices of C, respectively. There are several indices of growth efficiency at different temperatures. Its grown efficiency at different temperatures. Its temperature preferences cause the appearance of this prawn in South African west coast localities such as Langebaan during the summer and its disappearance during winter. It is possible that thermal pollution from a nuclear power station may be beneficial to this prawn. (Murphy-IVI) W84-03371

AQUATIC EFFECTS OF WET ASH DISPOSAL AND WET LIMESTONE SCRUBBER SYSTEMS,

Tennessee Valley Authority, Chattanooga. R. J. Ruane, J. D. Milligan, R. C. Young, T.-Y. J. Chu, and H. Olem.

### Field 5-WATER QUALITY MANAGEMENT AND PROTECTION

### Group 5C-Effects Of Pollution

Water Science and Technology, Vol. 15, No. 11, p 149-153, 1983.

Descriptors: \*Industrial wastes, \*Wastewater treatment, Scrubbers, Limestone, Ash, Fly ash, Coal, Groundwater pollution, Leachate, Sludge disposal.

Research on the major areas of concern for aquatic impacts in wet ash disposal and wet limestone SO2 scrubbers is reviewed. Emphasis is placed on monitoring efforts on ash pond effluents, lab studies on coal ashes, effects of coal-ash leachate on ground water quality, investigations on scrubbers sludge, and toxicity of ash pond effluents. (Baker-IVI)

ACID RAIN, CATCHMENT CHARACTERISTICS AND FISHERY STATUS,

Central Electricity Generating Board, Leather-head (England). Central Electricity Research P. F. Chester.

Water Science and Technology, Vol. 15, No. 12, p 47-58, 1983. 8 Fig, 13 Ref.

Descriptors: \*Acid rain, \*Catchment areas, \*Fisheries, Effective reactivity, Prediction, Oligotrophic lakes, Chemical properti

Data on lake chemistry and fishery status in the Sorlandet area of South Norway are examined for relationships between acid inputs, water composi-tion and fishery status. The effective catchment tion and fishery status. The effective catchment reactivity is a much better predictor of fishery status than is acid input to these catchments. An analysis of the only extensive published data set relating water chemistry to fishery status in oligotrophic acid lakes does not support the simple thesis that acid deposition has affected fishery status unless it is assumed that soil minerals or extense to characteristic have been altered subcatchment characteristics have been altered sub-stantially by acid deposition. To account for the reported changes in barrenness over the last 30-40 years, the effective reactivity or neutralizing capa-bility of the most affected catchments will have to decrease by a factor of two. It is unlikely that this happened so rapidly through depletion or exhaus-tion of base cations. Observation of catchment reactivity as revealed by simple measurements of reactivity as revealed by sample measurements of lake water chemistry over a period of a few years determine whether changes of the required magni-tude are occurring in the catchments. A proper understanding of the reactivities and biological ac-tivity of the catchments and their evolution with time is crucial for the specification of effective measures to counter the decline in fisheries. (Murphy-IVI) W84-03385

FISHERY STATUS AND WATER QUALITY IN AREAS AFFECTED BY ACID DEPOSITION, Central Electricity Generating Board, Leather-head (England). Central Electricity Research Labs

G. D. Howells. Water Science and Technology, Vol. 15, No. 12, p 67-80, 1983. 9 Fig, 3 Tab, 25 Ref.

Descriptors: \*Fish populations, \*Water quality, \*Acidity, Oligotrophic lakes, Fish, Mortality, Hydrogen ion concentration.

A review of current information from both field and laboratory investigations concerning the responses of fish and fish populations to natural acid conditions in Scandinavian and North American lakes and rivers, identifies the factors which determine survival and mortality. It is generally recognized that fisheries do not thrive in acid waters below pH 5. Fifty-percent of lakes below pH 5 are fishless, compared with only one in seven of similar oligotrophic lakes with pH greater than 5. Both field and laboratory studies provide evidence that other water quality factors (such as the levels of aluminium and calcium), biological factors (such as food supply, genetically determined tolerance, adpatation), and ecological factors (such as lake morphology, patterns of hydrological events) are also important. (Murphy-IVI) A review of current information from both field

RELIABILITY OF PLANT SYSTEMS, Ohio State Univ., Columbus RIVER-TREATMENT

R. M. Sykes.

Journal of Environmental Engineering, Vol. 110, No. 1, p 166-173, February, 1984. 1 Fig. 2 Tab, 7

Descriptors: \*Water pollution sources, \*Wastewater treatment, \*Pollution load, \*River flow, Drought, Low flow, Flow rate, Effluents,

The reliability of river - treatment plant systems is determined by considering fluctuations in both the streamflow rate and waste loading rate. The method involves an application of the elementary theory of hydrologic statistics and waste assimilation models to the cumulative density functions of the flow rates and loading rates. The products of the method are the expected number of system failures per drought, the interval between failures and the annual return period of droughts contained the product of the and the annual return period of droughts containing at least one systems failure. It is shown that the usual methods based on rare drought flows, (e.g., the seven-day average flow with a 10-yr return period) cannot provide this information. Also, designs based on rare drought flows are not conformable to stream standards, whereas designs based on the proposed method are intrinsically conformable to stream standards. (Author's abstract)
W84-03474

THE INFLUENCE OF THE GRAND RIVER ON PHYTOPLANKTON NEAR THE NORTHEAST-ERN SHORE OF LAKE ERIE DURING 1979, Ontario Ministry of the Environment, Rexdale. Limnology and Taxonomy Section.

K. H. Nicholls, R. Taylor, and Y. Hamdy. Archiv fur Hydrobiologie, Vol. 98, No. 2, p 146-172, October, 1983. 21 Fig, 3 Tab, 22 Ref.

Descriptors: \*Phytoplankton, \*Grand River, \*Lake Erie, \*Ontario, \*Water pollution effects, Biomass, Plant communities, Nutrients, Phosphorus, Eutrophication, Water quality.

The phytoplankton in the region of the Grand River and adjacent northeastern Lake Erie (Ontar-io, Canada) was investigated during April-Novemio, Canada) was investigated during April-Novem-ber of 1979 to determine the influence of the river on the phytoplankton of the lake. Average phyto-plankton biomass ranged from 0.45 cu mm/l in the lake to 7.6 cu mm/l in the river mouth. The phytoplankton communities of the two river mouth stations were most similar, but were related to those at the Lake Erie stations at much lower percentage similarities. Stations west of the Grand River were more similar to each other in phytoplankton community structure than to stations east of the Grand River. The influence of the Grand of the Grand River. The initiaence of the Grand River on Lake Erie phytoplankton was greatest during spring. The distribution of two indicator species, Skeletonema potamos (Weber) Halse and Stephanodiscus hantzschii Grun, suggests that the major influence of the Grand River during the summer was confined to an area within only 5-10 km of the river mouth. The nutrient and phyto-plankton data imply that further controls on phosphorus loading will achieve lower densities of algae and improved water clarity, especially in the river mouth area. (Author's abstract)
W84-03489

A COMPARATIVE SURVEY OF ANCYLUS FLUVIATILIS (MULLER) POPULATIONS IN THE AFON CRAFNANT, N. WALES, ABOVE AND BELOW AN INPUT OF ZINC FROM MINE-WASTE.

Liverpool Univ. (England). Dept. of Zoology. M. Willis.

Archiv fur Hydrobiologie, Vol. 98, No. 2, p 198-214, October, 1983. 5 Fig, 2 Tab, 20 Ref.

Descriptors: \*Acylus, \*Snails, \*Zinc, \*Water pollution effects, \*Afon Crafnant, \*Wales, Mine wastes, Reproduction, Population dynamics, Heavy metals, Toxicity.

The growth, reproductive success and population dynamics of Ancylus fluviatilis (Muller) were stud-

ied in a stream receiving zinc from mine-waste ied in a stream receiving zinc from mine-waste at two sites, one upstream and one downstream of the input, over an 18 month period. Samples were collected monthly by clearing 25 quadrats of all Ancylus at each site. Shell dimensions were measured using a binocular microscope with calibrated eyepiece and dial calipers. Histological techniques were employed to determine sexual maturity. Reproductive success was measured by estimating the number of egg-capsules and number of egg-capsules. productive success was measured by estimating the number of egg-capsules and number of eggs per capsule at each site. Wet ashing techniques fol-lowed by analysis using flame atomic adsorption spectrophotometry were used to determine the extent of bioaccumulated zinc. "Total" zinc and several other metals in the waters were measured several other metals in the waters were measured using flame atomic adsorption spectrophotometry. A small density of Ancylus was found at the site influenced by zinc. Spring-growth commenced approximately one month later at this site but a similar growth rate of the spats occurred during the summer months. Fewer eggs were found, egg-capsules were more likely to be empty and were smaller at the site influenced by zinc. More zinc was accumulated in the tissues of Ancylus at this site. (Author's abstract) W84-03490

PROPERTIES OF ACID BROWN WATER STREAMS IN SOUTH SWEDEN, Lund Univ. (Sweden). Dept. of Animal Ecology. C. Otto, and B. S. Svensson. Archiv fur Hydrobiologie, Vol. 99, No. 1, p 15-36, December, 1983. 8 Fig, 5 Tab, 56 Ref.

Descriptors: \*Acid streams, \*Sweden, \*Biological properties, \*Chemical properties, Hydrogen ion concentrations, Water pollution effects, Alkaline water, Light penetration, Aquatic fauna.

Whether direct or indirect, pH influences the composition of the fresh water fauna. Based on data from about 300 streams in southern Sweden, the lower pH levels at which common lotic invertebrates have been observed reveal that pH alone is not responsible for the documented impoverished fauna in acid/humic watersheds. A shredder, Potamophylax cingulatus, grew significantly larger in acid as compared to neutral and alkaline streams, despite evidence of physiological stress at low pH. An extended availability of leaf material was documented in the acid stream. A significant positive correlation between number of macroinvertebrate species and pH was established. Shredders and correlation between number of macroinvertebrate species and pH was established. Shredders and grazers were less abundant at low pH, whereas no significant correlation with pH was found for number of species of deposit feeders, filter feeders and predators. Relationships between pH, organic carbon, aluminum and light transmission were investigated from data obtained in 25 brown water transmit it is suggested that light penetration at the superferred penetration vestigated from data obtained in 25 brown water streams. It is suggested that light penetration at the bottom might be a limiting factor for primary production in such streams during the summer. Accumulation of aluminum in P. cingulatus larvae was low despite high background levels. The observation indicates that transport of aluminum from humic waters to terrestrial food chains is not very high. (Murphy-IVI) W84-03502

### 5D. Waste Treatment Processes

STUDIES ON STABILIZATION PONDS FOR DOMESTIC SEWAGE IN INDIA,
Government Post Graduate School, Sehore

Government Post Graduate (India). Dept. of Botany.

A. V. Rao. Internationale Revue der Gesamten Hydrobiolo-gie, Vol. 68, No. 3, p 411-434, 1983. 14 Fig, 15 Tab, 19 Ref.

Descriptors: \*Stabilization ponds, \*Domestic wastes, Biological oxygen demand, Chemical oxygen demand, Phosphates, Ntrogen, Bottom sediments, Chemical properties.

For one year a single cell stabilization pond, T. T. Nagar, Bhopal (August, 1968 to July, 1969) and series stabilization ponds, Shahpur, Bhopal (January, 1969 to December, 1969) were studied. Climatological conditions in Bhopal were favorable for

### WATER QUALITY MANAGEMENT AND PROTECTION—Field 5

### Waste Treatment Processes—Group 5D

the treatment of sewage in stabilization ponds. There was a considerable reduction in BOD, total nitrogen, phosphate, coliforms and enterococci during the process of treatment. The reductions were highest in series ponds. Diurnal variations had the highest pH, dissolved oxygen, algal cell number and lowest alkalinity values occur around 4.00 p.m. Algal flora present in the single cell pond consisted of 31 species representing 27 genera. In the series ponds 33 species belonging to 30 genera and 37 species belonging to 33 genera were in the primary and secondary ponds, respectively. (Murphy-IVI) W84-02957

SEDIMENTATION OF ZEOLITE TYPE A IN

WATER AND WASTEWATER, Lisbon Univ. (Portugal). For primary bibliographic entry see Field 5F. W84-02978

### BIOTECHNOLOGY AND EFFLUENT TREAT-

MENT, A. D. Wheatley, C. I. Winstanley, and L. Cassell. Effluent and Water Treatment Journal, Vol. 23, No. 8, p 307-316, August, 1983. 4 Fig, 4 Tab, 9 Ref.

Descriptors: \*Wastewater treatment, \*Water reuse, Activated sludge process, Filtration, Bioscrubbing, Adsorption, Biogas, Rotating biological contactors, Biological wastewater treatment.

Existing effluent treatment is reviewed emphasis-Existing effluent treatment is reviewed emphasising processes available for by-product recovery
and discussing the future prospects for environmental biotechnology for further recovery or
useful materials and the breakdown of reculcitrants. The most recent change in biological filtration has been the introduction of plastic media in
1970, extending the range of applications to include high concentration wastes vivial of industri-1970, extending the range of applications to include high concentration wastes typical of industrial effluents. Another innovation has been the rotating biological contactor (RBC) in which a honeycomb of plastic sheets are slowly rotated on a shaft through a tank containing the wastewater. Developments in the activated sludge processes include the use of pure oxygen in completely enclosed tanks in 1972. An innovative application to effluent treatment was the use of a deep air lift fermenter. Advancements are also considered in the areas of removal by adsorption, bioscrubbing, biogas, and the recovery of biomass. (Baker-IVI) W84-02979

## AERATED LAGOON SYSTEMS WITH IM-

PROVED PERFORMANCE, Clemson Univ., SC. Dept. of Environmental Systems Engineering.

Public Works, Vol. 114, No. 4, p 35-36, 1983. 2

Descriptors: \*Aerated lagoons, \*Wastewater treatment, Domestic wastes, Biochemical oxygen demand, Total suspended solids, Design criteria.

A dual-multicellular aerated lagoon system is described which offers a low-cost alternative to highscribed which others a low-cost anternauce to high-maintenance, mechanically complex secondary treatment systems, especially for the treatment of small domestic wastewater discharges. For domes-tic wastewaters such systems consist of a first cell tic wastewaters such systems consist of a first ceil in which sufficient aerator power (about 30 hp per million gallons of basin capacity) is applied to maintain all organic solids in suspension. It is followed by three cells, each of which is aerated at a power level (from 5 to 10 hp per million gallons of basin capacity) that permits the settleable fraction of the suspended solids in the effluent from the first cell to settle. Solids that settle form deposits in which the biodegradable materials decompose in a which the biodegradable materials decompose in a benthal environment, giving off methane gas. Re-moval of soluble biochemical oxygen demand is enhanced by the multicellular configuration of the system and the high concentration of bacterial biomass kept in suspension in the first cell. Low effluent suspended solids are achieved by the mul-ticellular configuration and by limiting the hydraulic retention time. For domestic wastewaters treat-ed in the southeast the retention time in the first

cell should be no more than 1.5 days and that in each of the other cells should be no more than about 1.2 days. As the system is relatively small in size, nonbiodegradable solids which accumulate at the bottom of the second, third, and fourth cells should be removed annually. However, these solids should be highly stable and ready for land disposal. (Baker-FRC) W84-02982

# ANTICIPATE FUTURE REQUIREMENTS FOR WASTEWATER HANDLING SYSTEMS,

Bechtel Associates, Ann Arbor, NJ.
J. O. Thaler, and P. K. Sinha.
Power Engineering, Vol. 87, No. 2, p 52-55, 1983.
2 Tab.

Descriptors: \*Wastewater treatment, \*Regulations, \*Legislation, Industrial wastes, Powerplants, Ash, Bottom ash, System design, Design criteria, Wastewater treatment facilities.

Wastewater handling is a subject of growing con-cern to operating power plants. Many National Pollutant Discharge Elimination System (NPDES) permits have expired, or are expiring, and there will be no definitive federal position on pollutant discharge until the effluent guidelines are finalized and promulgated. The EPA is currently active in reviewing the overall Clean Water Act and is reviewing the overall Clean Water Act and is drafting proposed revisions to be submitted soon to Congress. Limitations established up to this point are considered. The finalized first round regulations separated power plant discharges into six controlled waste categories: once through cooling water, recirculating cooling water system blowdown, ash transport water (fly ash and bottom ash), metal cleaning wastes and boiler blowdown, low-volume wastes (collective), and all categories. First round best practical control technology available limitations were aimed at controlling the discharge of free available chlorine, total suspended solids, oil/grease, pH, copper and iron. They also specified total elimination of discharges containing PCB compounds. First round NSPS (new source performance standards) limitations were similar but performance standards) limitations were similar but contained some limitations even more strict than best available technology limits. Management considerations must be given to total residual chlorine in once-through cooling water discharges, TRC in recirculating cooling water system blowdown, bottom ash transport systems, water based metal cleaning wastes, and coal pile precipitation runoff. (Baker-FRC) performance standards) limitations were similar but

THE INFLUENCE OF FLOW CONDITIONS ON THE REMOVAL OF HEAVY METALS IN THE PRIMARY SEDIMENTATION PROCESS, Imperial Coll. of Science and Technology, London (England). Public Health Engineering Lab. A. C. Rossin, R. M. Sterritt, and J. N. Lester. Water, Air, and Soil Pollution, Vol. 19, No. 2, p 105-121, 1983. 2 Fig, 7 Tab, 31 Ref.

Descriptors: \*Heavy metals, \*Wastewater treatment, Chromium, Copper, Lead, Nickel, Zinc, Cadmium, Flow, Suspended solids.

A pilot scale primary sedimentation pilot plant, treating raw sewage was used to assess the efficiency of removal of cadmium, chromium, copper, nickel, lead, and zinc. Heavy metal removals were determined during conditions designed to simulate normal dry weather flow, three times dry weather flow and diurnal variations in flow. During the study, the flows of sewage to the works where the pilot plant was were also varied. The efficiency of sewage treatment processes in removing heavy metals depends on two main factors: namely their existence as settleable particulate forms in the sewage and the conversion of soluble and nonsettleable forms within the process. The heavy metal removal efficiencies in the primary sedimentation pilot plant varied considerably not only in terms of the effects of hydraulic loading on the process, but also on different sampling occasions at the same hydraulic loading. These variations may have been due to the manner of heavy metal input to the process. It appeared that metal input was not a continuous process, since data indicated that the

concentrations of Cd, Cu, Pb, and Zn could increase by a factor of 2 to 3, and then return to initial concentrations in periods as short as 12 hr. In spite of the variations in concentrations of heavy metals in the sewage, the variations in percentage removals of heavy metals were much less and those variations in removal which did occur did not appear to be related to the heavy metal concentration. Metal removal was adversely affected by increasing the flow by a factor of three and by operating the plant under variable flow conditions. Suspended solids removal was not affected by increasing the flow. (Baker-FRC)

# INDUSTRIAL WASTE ELIMINATION - AN OPTIMAL SOLUTION,

Industrial Waste Elimination Research Center, Chicago, IL.
J. W. Patterson, and W. A. Cawley.

Industrial Wastes, Vol. 29, No. 2, p 10-13, March/ April, 1983. 4 Tab.

Descriptors: \*Industrial wastes, \*Wastewater treatment, Industrial Wastes Elimination Research Center, Water pollution control, Metals, Manage-

The historical and still current approach to indus-The historical and still current approach to industrial pollution control has been end-of-pipe treatment and discharge of the treated effluent. This end-of-pipe approach evolved to control conventional pollutants such as biochemical oxygen demand and suspended solids and, in most instances, remains valid for control of such pollutants. ants. However today we are also concerned with the identification and control of a wide spectrum the identification and control of a wine spectrum of toxicants, and innovative approaches and methodologies must be considered for treating them. The concept of pollution avoidance is gaining increasing acceptance as an alternative to conventional approaches to pollution control. It is an inherently attractive concept in that it addresses the opportunities to conserve valuable resources while avoiding the costs and environmental risks of ultimate waste dispersal. The Industrial Wastes Elimination Research Center (IWERC) has five Elimination Research Center (IWERC) has five research projects currently being coordinated and funded including projects focusing on metals re-covery, sorption/desorption recovery for organics, liquid-liquid membrane extraction techniques for organics and metals and catalysts. Most of the funding currently comes through block grants from EPA. (Murphy-IVI) W84-03040

#### THE ANAEROBIC APPROACH: A BETTER ANSWER.

Celanese Chemical Co., Bishop, TX. L. M. Harvey, and J. C. Rubiano. Industrial Wastes, Vol. 29, No. 2, p 22-25, March/April, 1983. 2 Fig, 2 Tab.

Descriptors: \*Wastewater treatment, \*Anaerobic conditions, Industrial wastes, Celanese Chemical Company, Bishop, Texas, Chemical wastes, Activated sludge process.

An anaerobic wastewater treatment process has been developed for high-strength industrial wastewaters. The system pretreats wastes in one location in order to reduce organic concentration for municipal discharge. At another location the same system, followed by aerobic polishing, provides organic COD reduction and odor abat on chemical wastes prior to disposal in solar evap-oration ponds. At the Celanese facility in Bishop, Texas a retrofit of the system to an existing activatlexas a retroit of the system to an existing activation of substantial designs and the plant's capacity and made possible the biodegradation of wastes which were previously classified as untreatable. The anaerobic system was expected to lower operating costs as a result of reduced aeration requirements of the aerobic system, net fuel value of the offgas produced in the anaerobic reactor, and reduced sludge production. The combined Celrobic anaerobic reactor and activated sludge system will provide for treatment of greater than 95% of the

### Field 5-WATER QUALITY MANAGEMENT AND PROTECTION

### **Group 5D—Waste Treatment Processes**

plant's organic wastewaters through the 1980s. (Baker-IVI) W84-03042

TRANSFERABLE DISCHARGE PERMITS AND TRANSFERABLE DISCHARGE PERMITS AND ECONOMIC EFFICIENCY: THE FOX RIVER, Colby Coll., Waterville, ME. Dept. of Economics. W. O'Neill, M. David, C. Moore, and E. Joeres. Journal of Environmental Economics and Management, Vol. 10, p 346-355, 1983. 3 Fig, 4 Tab, 9 Ref.

Descriptors: \*Wastewater disposal, \*Economic efficiency, \*Permits, \*Fox River, Wisconsin, Economic feasibility, Cost analysis, Economic evaluation, Systems analysis, Computer models, Mathematical models, Pollution load, Water pollution control

Recent emphasis on reforms of environmental reg-ulation has led to suggestions for strategies which maintain environmental standards but allow the maintain environmental standards out allow the needed flexibility and cost effectiveness. The trans-ferable discharge permit (TDP) is one such strate-gy for water pollution control recently adopted in Wisconsin. There was substantial cost savings from wiscommin. There was substantial cost savings from trading TDPs from data on the Fox River in Wisconsin. A simulation model of water quality (Qual-III) and a linear programming model of abatement costs determine the optimum pattern of discharge. Reaching that optimum from proposed pollution abatement orders is feasible. Varying pollution abatement orders is feasible. Varying conditions of flow and temperature can be accommodated using trade coefficients which can be accurately estimated through interpolation. The calculations are valuable and feasible in conjunction with the flexible regulations governing water pollution abatement. There is no obstacle to trading permits even when the permit itself varies in proportion to the assimilative capacity of the river.
(Murphy-IVI)
W84-03046

SUBSURFACE INJECTION OF TREATED SEWAGE INTO A SALINE-WATER AQUIFER AT ST. PETERSBURG, FLORIDA - AQUIFER PRESSURE BUILDUP,

Geological Survey, Tampa, FL. J. J. Hickey. Ground Water, Vol. 22, No. 1, p 48-55, January-February, 1984. 6 Fig. 10 Ref.

Descriptors: \*Florida, \*St. Petersburg, \*Injection wells, \*Underground waste disposal, \*High pressure, \*Aquifers, \*Confined groundwater, Wastewater disposal, Chlorides, Groundwater movement, Municipal wastewater.

The city of St. Petersburg has been testing subsur-face injection of treated sewage into the Floridan aquifer as a means of eliminating discharge of sewage to surface waters and as a means of storing treated sewage for future non-potable reuse. The injection zone originally contained native saline ground water that was similar in composition to sea water. The zone has a transmissivity of about 0.000012 sq feet/day and is within the lower part of the Floridan aquifer. Treated sewage that had a mean chloride concentration of 170 (mg/l) was injected through a single well for 12 months at a mean rate of 0.000047 cubic feet/day. The volume of water injected during the year was 1.7 times 10 to the 8th power cubic feet. Pressure buildup at the to the 8th power cubic feet. Pressure buildup at the end of one year ranged from less than 0.1 to as much as 2.4 pounds/sq inch in observation wells at the site. Pressure buildup in wells open to the upper part of the injection zone was related to buoyant lift acting on the mixed water in the injection zone in addition to subsurface injection through the injection well. Calculations of the vertical component of pore velocity in the semi-confining bed underlying the shallowest permeable zone of the Floridan aquifer indicate upward movement of native water. This is consistent with the 200 to 600 mg/l increase in chloride concentrathe 200 to 600 mg/l increase in chloride concentra-tion observed in water from the shallowest permeable zone during the test. (Author's abstract)

MODELS FOR WATER WASTEWATER PLANNING. REUSE AND California State Water Resources Control Board,

Sacramento.

M. Schwartz, and L. W. Mays.
Journal of Environmental Engineering, Vol. 109,
No. 5, p 1128-1147, October, 1983. 3 Fig. 5 Tab, 16

Descriptors: \*Mathematical models, \*Water reuse, \*Wastewater management, \*Optimum development plans, Management planning, Cost analysis, Water treatment facilities, Maintenance costs, Operating costs, Costs, San Antonio, Texas.

The concepts of both water conservation and reuse are important in obtaining the maximum utility of water resources. A planning model for the deter-mination of optimal water reuse allocation and wastewater treatment alternatives minimizes the overall cost of water supply and wastewater treatment over a planning period. The planning model consists of two models, each based upon dynamic programming (DP). The first model is an allocation DP model, which is used for the optimal allocation of water to users for each treatment alternative considered. The second model is a treatment DP model, which performs the optimal selection of treatment alternatives over time. The wastewater treatment alternatives minimizes the selection of treatment alternatives over time. The allocation DP model is used to define the state space for the treatment DP model. Application of the planning model is made to San Antonio, Texas. (Murphy-IVI) W84-03091

LAGOON EFFLUENT POLISHING WITH INTERMITTENT SAND FILTERS,

Carollo (John) Engineers, Phoenix, AZ. J. S. Russell, E. J. Middlebrooks, R. F. Lewis, and

Journal of Environmental Engineering, Vol. 109, No. 6, p 1333-1353, December, 1983. 11 Tab, 9

Descriptors: \*Wastewater lagoons, \*Effluent polishing, \*Sand filters, \*Intermittent filters, Municipal wastewaters, Water quality, Water quality standards, Secondary wastewater treatment, Cost analysis, Biochemical Oxygen demand.

Intermittent sand filters are economical and as simple to operate as wastewater lagoons. All but one of the three lagoon-intermittent sand filter systems treating municipal wastewaters monitored satisfied the 1972 federal secondary treatment discharge standards for BOD5, and that facility removed 84% of the BOD5 instead of the required 85% removal. The 30-day mean effluent BOD5 concentrations for all three systems ranged from 3-21 mg/L with a percentage removal range of 84%-98%. The 30-day mean effluent SS concentrations ranged from 8-21 mg/L. Eighty five percent reranged from 8-21 mg/L. Eignty live percent re-moval of SS was not achieved during two of the nine sampling periods. At no time did the 30-day geometric mean effluent fecal coliform concentra-tion of the three systems exceed 200 organisms/100 tion of the three systems exceed 200 organisms/100 ml. Geometric mean fecal coliform concentrations of less than 200 organisms/100 ml were produced without disinfection. Only three of 260 effluent samples had a pH value that did not lie within the required range of 6.0 to 9.0. Total treatment costs for the three filters evaluated ranged from \$0.04-\$0.06 per cu m of filtrate. (Murphy-IVI) W84-03096

TREATMENT PLANTS ENTER COMPUTER IMMERSION PHASE.

V. von Buchstab. Water and Pollution Control, Vol. 121, No. 2, p 18-22, March/April, 1983.

Descriptors: \*Water treatment facilities, \*Computers, \*Wastewater treatment, Management, Costbenefit analysis, Energy, Financial aspects.

The most immediate benefits of entering the com-puter immersion phase has been reduced labor costs and reassignments leading to higher mainte-nance orientation in some plants. The common thread running through the interviews with man-agement of wastewater treatment and water treatment facilities was that municipalities, like all other clients, need to know the cost/benefits of their expenditures. Manpower savings are the best docuexpenditures. Manpower savings are the best docu-mented incentives to automate. Other factors in-clude energy savings. Control schemes are now scavenging the energy content of sewage off-gases, for such functions as heating the digestion process-es to optimal temperatures, or the use of methane to drive small, auxillary motors. More importantly, load-shedding schemes mean reduced hydrode-mand charges by thoughtful load staggering. (Murphy-IVI)

NEW WATER AND WASTEWATER SYSTEMS FOR ELLIOT LAKE,

Water and Pollution Control, Vol. 121, No. 5, p 8-10, 17, 33, September/October, 1983. 5 Fig.

Descriptors: \*Water treatment facilities, \*Wastewater treatment facilities, Elliot Lake, Activated sludge process, Chlorination, Filtration, Fluoridation, Design criteria, Planning, Decision making.

In the past two years \$24 million has been spent on new water and sewage systems for Elliot Lake. The existing water plant was to be replaced with a 29,100 cubic m/day water treatment plant incorporating filtration, fluoridation and chlorination, designed to supply a population of 28,000. The plant's source of water is Elliot Lake, situated deep in the granitic Canadian shield. In addition the Estern Lake Sewage Treatment Plant was commissioned in December 1981 after only 11 months of construction. This plant uses a conventional activated sludge process to provide secondary treatvated sludge process to provide secondary treatment of a nominal design flow of 16,000 cubic m/day and a peak of 36,000 cubic m/day. Both systems are owned and operated by the town. (Baker-(VI) W84-03100

OCCURRENCE OF LOW- AND HIGH-CHLOR-INATED PHENOLS IN MUNICIPAL SEWAGE BEFORE AND AFTER PASSING THROUGH BIOLOGICAL TREATMENT PLANTS,

Vandkvalitetsinstitutet, Hoersholm (Denmark). J. Folke, and U. Lund. Journal of Chromatography, Vol. 279, p 189-198, 1983. 3 Fig, 2 Tab, 18 Ref.

Descriptors: \*Wastewater analysis, \*Chlorinated phenols, \*Biological wastewater treatment, Gas chromatography, Mass spectrometry, Phenols,

Four Danish biological treatment plants for municipal sewage (located in the center of Copenhagen, in the Greater Copenhagen area, in a provincial town in Jutland with 56,000 inhabitants, and in a provincial town on Sealand with 29,000 inhabit-ants) were examined for their chlorophenol content and their ability to degrade these compounds None of these plants was known to be charged with industrial wastewater containing chlorophen-ols. A routine method for the analysis of both lowols. A routine method for the analysis of both lowand high-chlorinated phenols was developed,
based on gas chromatography with electron-capture detection (GC-ECD). The method was evaluted by comparing the GC-ECD results with those
obtained by combined gas chromatography-mass
spectrometry with selected-ion monitoring, GCMS(SIM), of the molecular ions of the specific
phenols. The sensitivity of the GC-ECD method
for the individual phenols increases with increasing
number of chloro substituents The GC MS(SIM)
method is better for the determination of lowand one-chlorinated phenols. The GC-ECD method non-chlorinated phenols. The GC-ECD method has a greater sensitivity for the higher chlorinated phenols. The advantage that the GC-MS(SIM) phenols. The advantage that the GC-MS(SIM) method is free from errors caused by interfering compounds must be weighed against the advan-tages of the GC-ECD method, which is less costly with regard to instruments and more easily adapted to routine analyses. The total phenol content, determined by GC-ECD showed a good correlation with the phenol number, obtained by using the 4-aminoantipyrine method. (Moore-IVI) W84-03159

### Waste Treatment Processes—Group 5D

SEPARATION OF BACTERIA FROM A METH-ANGENIC WASTEWATER POPULATION BY UTILIZING A SELF-GENERATING PERCOLL

GRADIENT, Hamburg Univ. (Germany, F.R.). Inst. fuer Allge meine Botanik.

P. Scherer.

Journal of Applied Bacteriology, Vol. 55, No. 3, p 481-486, December, 1983. 1 Fig. 13 Ref.

Descriptors: \*Bacterial analysis, \*Density gradient separation, \*Wastewater analysis, \*Methane bacteria, Wastewater treatment, Sulfur bacteria, Methosarcina, Methanothrix, Desulfovibrio

Percoll consists of polyvinylpyrrolidone coated colloidal silica-gel particles which form a distribu-tion of nearly spherical particles with a mean diam-eter of 17-30 nm. Bacteria from a methanogenic wastewater population could be separated with a self-generating density gradient of Percoll. The separation was performed by centrifugation for 30 min at 30000 g in a simple angle-head rotor. Three types of bacteria were concentrated to apparent homogeneity in different bands: these were attributed to the methanogens Methanosarcina and Methanothrix, and to the dissimilatory sulfate-reducing bacterium Desulfovibrio. By the addition of colored marker beads with a known density, the buoyant density of fractions can be estimated in the ouoyant density of fractions can be estimated in the same centrifugation. This method should facilitate bacterial analysis of wastewater and should con-tribute to the understanding of the bacteria con-cerned with wastewater treatment. (Moore-IVI) W84-03164

SLUDGE TREATMENT BY OXYOZOSYNTHE-SIS STOPS OCEAN DUMPING.

S. A. Peterson, and E. Mozell.
Public Works, Vol. 15, No. 1, p 42-43, January, 1984. 1 Fig, 1 Tab.

Descriptors: \*Sludge treatment, \*Oxyozosynthesis, \*Sludge disposal, Sludge cake, Ozone, Oxygen, Cost analysis, West New York, New Jersey.

West New York's (New Jersey) sewage is treated by primary clarifyers. The sludge is moved into a 3,000-gallon pressurized reactor vessel where ox-yozosynthesis treatment takes place. The atmosphere within the reactor consists of a 2:1 ratio of oxygen to ozone at a pressure of 60 psi. The source of ozone is a generator that converts oxygen gas to of ozone is a generator that converts oxygen gas to ozone. The total pressurizing and processing time per batch is 90 minutes. The process converts the sewage sludge into CROAL, an odorless, almost completely sterile cake. The CROAL, which more than meets federal and New Jersey standards for land application, is trucked to a nearby landfill. land application, is trucked to a nearby landrill.

Before adopting the oxyozosynthesis process, the
town disposed of sludge by ocean dumping, at an
annual cost of \$170,000; total annual cost for treatment by the oxyozosynthesis process is only
\$110,000. (Murphy-IVI)

GROWTH OF SALVINIA MOLESTA AS AFFECTED BY WATER TEMPERATURE AND NUTRITION; II. EFFECTS OF PHOSPHORUS

Commonwealth Scientific and Industrial Research Organization, Griffith (Australia). Div. of Irrigation Research

For primary bibliographic entry see Field 5C. W84-03192

EFFECTS OF WASTEWATER IRRIGATION AND PLANT AND ROW SPACING ON SOY-BEAN YIELD AND DEVELOPMENT, Michigan State Univ., East Lansing. Dept. of Crop

and Soil Sciences. For primary bibliographic entry see Field 3C. W84-03271

DECHLORINATION OF WASTEWATER AND COOLING WATER,
Maryland Univ., College Park. Dept. of Chemis-

try.
G. R. Helz, and L. Kosak-Channing.

Environmental Science and Technology, Vol. 18, No. 2, p 48A-55A, February, 1984. 87 Ref.

Descriptors: \*Dechlorination, \*Wastewater treatment, \*Cooling water, Environmental effects, Effluents, Reviews, Sulfur dioxide.

A growing movement is under way in the United States to install dechlorination facilities, particular-ly at sewage treatment plants, to alleviate damage to downstream ecosystems. A thorough review determined that research is needed in treatment technology, downstream chemical effects and downstream biological effects of dechlorination. In treatment technology better SO2 application and control systems are needed. For downstream chemical effects, the effect of S(IV) compounds on chemical effects, the effect of S(IV) compounds on trace metal geochemistry is important, particularly whether S(IV) compounds cause reductive dissolu-tion of the Fe and Mn oxyhydroxides in a river's suspended load. To determine the effectiveness of dechlorination long-term and sublethal effects, such as effects on reproduction and avoidance behavior are also presents. (Murph, IVI) behavior, are also necessary. (Murphy-IVI) W84-03325

TECHNICAL NOTE: ADSORPTION OF P-DICHLOROBENZENE FROM WATER, M. Pirbazari, and W. J. Weber, Jr. Journal American Water Works Association, p 82-84, February, 1984. 4 Fig, 9 Ref.

Descriptors: \*Adsorption, \*Dichlorobenzene, Granular activated carbon, Humic acids, Water treatment

The results of granular activated carbon adsorption studies for para-dichlorobenzene from water in the presence of a major class of naturally occurring compounds - humic acids, is presented. With a load of PDB as high as 185 micrograms/liter an empty bed contact time of only 0.17 min, and a hydraulic loading of 2.6 mm/sec, approximately 78,800 bed volumes of water were treated before an effluent breakthrough level of 1 microgram/liter was reached. The effectiveness of activated carbon for PDB removal appears not to be adversely affected by background organics such as humic acids. PDB adsorption by carbon appears readily reversible, suggesting that uptake from solution occurs primarily because of relatively weak van der Walls' attraction forces. The MADAM model was generally able to simulate and predict the performance of fixed-bed adsorbers for removal of PDB. (Baker-IVI) W84\_03370

TREATMENT OF ALKALINE WASTEWATER FROM LIGNITE-FIRED POWER PLANTS, Wroclaw Technical Univ. (Poland). Inst. of Envi-

roment Protection Engineering.
A. M. Dziubek, and A. L. Kowal.
Water Science and Technology, Vol. 15, No. 11, p
155-162, 1983. 4 Fig. 2 Tab, 7 Ref.

Descriptors: \*Wastewater treatment, \*Alkaline water, Powerplants, Lignite, Aeration, Chemical composition, Calcium carbonate, Carbonates.

Alkaline wastewaters produced in the hydrotran-Arkaine wastewaters produced in the hydrotransport of some lignite ashes from the powerplant to the storage site have a high acidity and a high total hardness, so they cannot be discharged into a natural water course without treatment. Recom-mended are the attenuation of the alkalies contained in them, and precipitation of calcium car-bonate. These experiments have substantiated the efficiency of recarbonation and aeration, two treatment procedures which may be of importance from the environmental viewpoint in that they employ no additional chemicals. As a result of aeration pH was decreased to a level of about 7.8, and alkalimity to a level of 30 to 50 g calcium carbonate/cu m, irrespective of the initial alkalimitation. ty value. The minimum time of aeration required to achieve the highest degree of precipitation varied from 4 to 8 hr, depending on the initial alkalinity level. Expended times of aeration required in the recarbonation process can be shortened by employing primary recarbonation with pure carbon dioxide or flue gases unitl a pH of 9.5

is reached. The further decrease of pH can be achieved by aeration. An additional advantage of this method is that the flocculation conditions for the precipitated calcium carbonate are evidently improved and the time needed for sedimentation is shortened following the recarbonation process. W84-03376

LANDFILL LEACHATE TREATMENT,

Pennsylvania Univ., Philadelphia. Dept. of Civil and Urban Engineering.

J. D. Keenan, R. L. Steiner, and A. A. Fungaroli.

Journal of the Water Pollution Control Federation, Vol. 56, No. 1, p 27-33, January 1984. 1 Fig, 9 Tab, 7 Ref. EPA grant S-803926.

Descriptors: \*Leachates, \*Landfills, \*Wastewater treatment, Municipal wastewater, Industrial wastes, Heavy metals, Copper, Iron, Mercury, Zinc, Nickel, Lead, Sedimentation, Ammonia stripping, Neutralization, Activated sludge proc-

Landfill leachate is often a high-strength wastewater characterized by extremes of pH, biochemical oxygen demand, chemical oxygen demand, and heavy metals. In addition, it is a wastewater which is variable from landfill to landfill, and over time and space at a particular landfill. Consequently, neither biological waste treatment nor chemical-physical treatment separtely achieves high removal efficiency. The leachate treatment facility used in this study is located at a landfill in Falls Township. Bucks County. Pa. The plant is Falls Township, Bucks County, Pa. The plant is designed to provide maximum operational flexibility to permit full-scale testing of a variety of treatity to permit full-scale testing of a variety of treat-ment sequences. The sanitary landfill has a surface area of 50 acres, receives about 800 tons of refuse per day, 85% of which is municipal. The balance is industrial sludges and solid waste. The leachate is characterized by high concentrations of organic compounds which vary significantly day-to-day. Activated sludge treatment of the effluent from the chemical/physical units was extremely successful. The reduction in ammonia. M afford by the acres ful. The reduction in ammonia-N afforded by the ammonia stripping lagoon provided conditions suitable for the growth of activated sludge microorga-nisms. Overall the treatment sequence of lime precipitation, sedimentation, ammonia stripping, and neutralization followed by activated sludge pro-duced an excellent final effluent with the following characteristics: organic matter reduced to 153 mg BOD-5/l, a 99% reduction; an effluent ammonia concentration of 75 mg/l which represented a 90% removal; and heavy metal concentrations of 0.07 mg chromium/l, 0.11 mg copper/liter, 2.7 mg iron/l, 0.12 mg lead/l, 0.004 mg mercury/l, 0.75 mg nickel/l and 0.53 mg zinc/l. (Baker-IVI)

RENOVATION OF WASTEWATER AT THE 23RD AVENUE RAPID INFILTRATION PROJECT,

H. Bouwer, and R. C. Rice. Journal of the Water Pollution Control Federation, Vol. 56, No. 1, p 76-82, January, 1984. 2 Fig, 5 Tab, 16 Ref. EPA project S-802435.

Descriptors: \*Wastewater treatment, \*Infiltration, Water reuse, Activated sludge treatment, Soil-aqui-fer treatment, Ammonia, Phosphates, Coliforms, Irrigation, Recreation demand.

In arid areas, wastewater is an important resource that can be used for irrigation, recreational lakes, power plant cooling, and even for municipal purpower plant cooling, and even for municipal pur-poses with adequate treatment. Where hydrogeolo-gic conditions and land availability are favorable for groundwater recharge with infiltration basins, considerable quality improvement of the wastewater can be obtained by soil-aquifer treat-ment (SAT). An oxidation pond of 16 ha below the Phoenix 23rd Avenue Sewage Treatment Plant was split into four parallel infiltration basins to was spin into four paranet influration obstills to study large-scale renovation of secondary effluent by soil-aquifer treatment obtained by groundwater recharge using rapid infilration basins. The result-ing renovated water can be pumped from the aquifer for unrestricted irrigation and recreational

### Field 5-WATER QUALITY MANAGEMENT AND PROTECTION

### **Group 5D—Waste Treatment Processes**

lakes. Where the wastewater is to be recycled for drinking, soil-aquifer filtration provides an effec-tive pretreatment of the water for activated carbon treatment, reverse osmosis, and disinfection.

SOIL-AOUIFER TREATMENT USING PRI-

R. C. Rice, and H. Bouwer. Journal of the Water Pollution Control Federation, Vol. 56, No. 1, p 84-88, January, 1984. 6 Fig. 4 Tab, 8 Ref.

Descriptors: \*Wastewater treatment, \*Municipal wastes, Soil aquifer treatment, Suspended solids, Soil properties, Infiltration, Permeability coeffi-

Soil aquifer treatment of primary effluent is able to produce renovated water of equal or better quality than that obtained when using secondary effluen. The soil system can handle the higher organic carbon load of the primary effluent and provide adequate removal of bacteria and viruses. The acequate removal or bacteria and viruses. The infiltration capacity of the system depends on the hydraulic conductivity of the soil and the concentration and composition of the suspended solids. When the suspended solids are largely organic, most of the solids will accumulate on the soil most of the solids will accumulate on the soil surface where they are rapidly decomposed. Infiltration rates are restored after drying or by scarifying the surface by raking or harrowing. When the effluent contains fine inorganic solids, in-depth clogging may occur. The fine particles migrate downward and do not decompose, so that annual deep cultivation is needed to break up the clogged zone. A hydraulic loading capacity of 27 to 51 m/yr was obtained with an inundation schedule of 1 week wet and 1 week dry in the winter. This hydraulic loading represented 5 to 8% of the infiltration capacity of the soil or about 50% of the infiltration capacity of 20% of

FLOCCULENT SETTLING IN QUIESCENT SYSTEMS,

Geraghty and Miller, Inc., Baton Rouge, LA T. Y. R. Lo, and W. J. Weber, Jr. Journal of Environmental Engineering, Vol. 110, No. 1, February, 1984. 12 Fig, 2 Tab, 16 Ref.

Descriptors: \*Sedimentation, \*Flocculent settling, \*Settling rates, Suspended solids, Wastewater treatment, Settling velocity, Wastewater, Mathematical equations.

Characterization of the setting properties of sus-pensions for purposes of settling basin design and for prediction of suspended solids behavior in natural water systems is traditionally based on observa-tions of settling rates of dilute suspensions in quies-cent columns. Most suspensions of practical inter-est for water and waste treatment systems and natural aquatic environments are flocculent in character, and their settling cannot be described accurately in terms of minimum settling velocities. An empirical equation for description of the distri-bution of flocculent solids in quiescent settling columns was developed. The equation is predicat-ed on observations made in the course of concen-tration-depth-time analyses of settling data for floced on observations made in the course of concentration-depth-time analyses of settling data for floc-culent and nonflocculent solids in quiescent and agitated settling columns. The validity of the equa-tion is verified by its application to ten different quiescent flocculent settling studies involving sev-eral sewages and natural lake and river suspen-sions. Application of the equation involves evalua-tion of two parameters: the flocculation coefficient and the discrete-equivalent velocity distribution. (Moore-IVI)

CHEMICAL OPTIMIZATION OF TERTIARY CONTACT FILTERS

Eidgenoessische Anstalt fuer Wasserversorgung, Abwasserreinigung und Gewaesserschultz, Due-bendorf (Switzerland). M. A. Boller.

Journal of Environmental Engineering, Vol. 110, No. 1, p 263-276, February, 1984. 12 Fig, 4 Tab, 18

Descriptors: \*Contact filters, \*Precipitation, \*Phosphorus removal, Wastewater treatr Filtration, Polymers.

Pre- or simultaneous precipitation combined with contact filtration for final treatment is an excellent method to achieve low phosphorus residuals in waste-water discharges to lakes. The two dosing steps are optimized to allow for log chemical use and sufficiently long filter runs. If an Fe/P dissolved-ratio of about 2.0 is used in the first step, the Fe(III)-dosage to the second step may be kept below 4 g Fe(III)/cm. This allows the precipitates together with the solids from the secondary clarifier to be removed in multi-media filters. The clarifier to be removed in multi-media filters. The unfavorable filtering characteristics of the precipitates may be improved by dosing filter aids. In laboratory scale experiments low concentrations of nonionic polyacrylic polymers with high molecu-lar weight showed best filter performance. Under optimized conditions with respect to precipitant and filter aid dosage, a full-scale treatment plant was investigated. Consistent low phosphorus residuals at 0.1-0.2 g P/cu m was reached at mean filtration rates of 7.4 m/h and average filter runs of 20 hr. (Author's abstract) W84-03479

### 5E. Ultimate Disposal Of Wastes

APPRAISING WASTEWATER DISCHARGE COMPLIANCE LEVELS, Allied Chemical Corp., Morristown, NJ. Corpo-rate Research Center. For primary bibliographic entry see Field 6B. W84-03047

EFFECTS OF INDUSTRIAL BOILER BLOW-DOWN DISCHARGES ON STREAMS, Tennessee Dept. of Public Health, Nashville. For primary bibliographic entry see Field 5C. W84-03051

SLUDGE TREATMENT BY OXYOZOSYNTHE-SIS STOPS OCEAN DUMPING, For primary bibliographic entry see Field 5D. W84-03190

THE HANDLING AND DISPOSAL OF COAL ASH IN THE CEGB IN RELATION TO THE

ASH IN THE CEGB IN RELATION TO THE AQUEOUS ENVIRONMENT, Central Electricity Generating Board, Manchester (England). Scientific Services Dept.

J. Brown, and N. J. Ray.
Water Science and Technology, Vol. 15, No. 11, p. 11-24, 1983. 1 Fig. 7 Tab, 4 Ref.

Descriptors: \*Handling, \*Disposal, \*Coal ash, \*Central Electric Generating Board, \*Aquatic environment, Percolation, Coal effluents, Groundwater, Aquifer characteristics, Slurries, Suspended

Pulverised fuel ash (pfa) and furnance bottom ash (ba) are the Principal solid wastes from modern coal fired plants. These residues are often handled and disposed of as slurries and pfa is frequently used for the reclamation of derelict land. One factor which requires careful management is the level of suspended solids in the outfall when a lagoon is nearly full. Whether ash is disposed of wet, or merely conditioned with water to facilitate handling. there may be a further need to consider. handling, there may be a further need to consider the percolation of water through the ash and its possible interaction with groundwater. This calls for knowledge or study of the ash itself, the size of the area to be reclaimed, the rainfall pattern and the local hydrogeology, including the size and rate of recharge of the aquifer. The basic Central Electricity Generating Board requires the combination of laboratory studies of percolate quality with hy-drogeological assessment to evaluate the potential risks, if any. The actual consent to dispose of ash, taking such factors into account, is made by the Local Authority in consultation with the Water Authority. The present view of ash disposal rela-tive to the supeous environment could be disturbed tive to the aqueous environment could be disturbed if legislation and the associated Codes of Practice were to become more stringent. (Murphy-IVI) W84-03373

STUDIES ON THE LEACHING AND WEATH-ERING PROCESSES OF COAL ASHES, Royal Inst. of Tech., Stockholm (Sweden). Dept. of Inorganic Chemistry. H. Liem, M. Sandstrom, T. Wallin, A. Carne, and

U. Rydevik. Water Science and Technology, Vol. 15, No. 11, p 163-191, 1983. 15 Fig, 7 Tab, 6 Ref.

Descriptors: \*Leaching, \*Weathering, \*Coal, \*Ashes, Computer programs, HALTAFALL, Metals, Hydrogren ion concentration, Mass-action

The Swedish project Coal-Health-Environment studies leaching on several types of coal ashes, fly ashes, bottom ashes and scrubber sludges to determine the effects of pH, pCl, pCO3, pEDTA and pSO4 in the leaching solution on the leaching of metals from coal ashes. The leaching of Cr, Co, Ni, Cu, Zn, Mo, Se, As, Cd, and Pb increases with pH for pH less than 2 and pH greater than 9, and decreases for pH greater than 2 but less than 6. The metal leaching behavior may in part be explained by the mass-action law. Through X-ray diffraction techniques the dominating crystalline phases in the different coal ashes were mullite (3A12 times 2SiO2), alpha-quartz (SiO2) and the iron oxides magnetite and hematite. Equilibrium analysis on various metals and compounds were made partly using the computer program HAL-The Swedish project Coal-Health-Environment made partly using the computer program HAL-TAFALL. (Murphy-IVI) W84-03377

USE OF 'THE CAPILLARY BARRIER' AS A SHIELD AGAINST GROUNDWATER POLLUTION FROM FLY-ASH DEPOSITS,

Danmarks Geologiske Undersoegelse, Copenhagen. Hydrogeological Div.
L. J. Andersen, and B. Madsen.
Water Science and Technology, Vol. 15, No. 11, p
207-212, 1983. 4 Fig, 4 Ref.

Descriptors: \*Capillary barrier, \*Groundwater Pollution, \*Fly ash, Capillarity, Membranes, Permeability, Semipermeable membranes, Leaching,

The enormous amounts of fly ash produced by the burning of coal in power plants have resulted in a number of environmental problems, not least of which is the increased risk of groundwater pollution from its deposition in gravel pits. In order to prevent this pollution, fly ash deposits have often been established with an underlying membrane. Such membrane-systems are quite expensive to build and necessities a continuous numning and Such membrane-systems are quite expensive to build and necessitate a continuous pumping and removal of percolate. The alternative of covering the fly ash with a low-permeable membrane, which removes the infiltrated water laterally, prevents not only groundwater pollution but also the formation of percolate. By using the principle of 'The Capillary Barrier,' the low-permeable membrane can be constructed of natural and resistant porous materials. (Murphy-IVI) W84-03378

PREVENTION OF WATER POLLUTION BY THE USE OF FLY-ASH AS A SUBSTITUTE FOR EXTRACTED RAW MATERIALS, Miljoeministeriet, Copenhagen (Denmark).

J. Lyngvig. Water Science and Technology, Vol. 15., No. 11, p 213-222, 1983. 3 Fig, 3 Tab.

Descriptors: \*Waste disposal, \*Waste recovery, Industrial wastes, Powerplants, Fly ash, Building materials, Clay, Gravel.

### WATER QUALITY MANAGEMENT AND PROTECTION—Field 5

### Water Treatment and Quality Alteration-Group 5F

One of the major problems in disposing of big quantities of fly-ash is the possible washing out of heavy metals which may pollute subsoil water. The washing out of chlorides and sulfates is also of concern. The use of fly-ash as a substitution material for gravel and clay has to be regarded as a way of disposing of a waste product as well as a way of saving the limited resources of natural raw materi-als and also as a technical and economical innovaals and also as a technical and economical innova-tion in the building and construction industries. A brief history of the Raw Materials Act is offered along with a listing of possible applications of waste products, documentation for the use of fly-ash as a substitution material and possibilities for the future. (Baker-IVI) W84-03379

MODEL OF ION EQUILIBRIUM IN AQUE-OUS SOLUTIONS OF FLY ASH IN THE CON-TEXT OF PREDICTION OF GROUND AND SURFACE WATER CONTAMINATION, Instytut Ksztaltowania Srodowiska, Katowice (Poland). Environmental Pollution Abatement

Centre.

For primary bibliographic entry see Field 5B. W84-03381

### 5F. Water Treatment and **Quality Alteration**

SEDIMENTATION OF ZEOLITE TYPE A IN WATER AND WASTEWATER, Lisbon Univ. (Portugal).
M. J. T. Carrondo, J. N. Lester, and R. Perry. Effluent and Water Treatment Journal, Vol. 23, No. 7, p 271, 273-280, July, 1983. 11 Fig, 5 Tab, 29

Descriptors: \*Detergents, \*Water treatment, \*Wastewater treatment, Water pollution sources, Phosphorous, Zeolite type A, Aluminosilicates,

Zeolite type A is a synthetic aluminosilicate which may be used to partly replace phosphorus compounds as detergent builders. The settling behavior of zeolite type A in water and wastewater was investigated. The use of Stokes' law in conjunction with the particle size distribution yields reasonably accurate predictions for the removal of zeolite type accurate predictions for the removal of zeolite type A when compared with the results of settling column tests, although the particles are not spheri-cal. The removals computed from the integration of settling curves obtained from column tests com-pare well with the model tank tests, although the tank removals are marginally lower. Even at low overflow rates, removal of zeolite type A in water was low. As anticipated, zeolite type A in concen-trations of about 30 mg/liter was removed at a faster rate from sewage than would be predicted faster rate from sewage than would be predicted by Stokes' law. When zeolite type A was present in raw sewage at about 30 mg/liter the percentage of suspended solids removed in static column tests was marginally reduced from the values obtained in raw sewage when zeolite was absent. Under flocculant settling conditions in raw sewage zeolite Rocculant settling conditions in raw sewage zeolite type A was removed to a lesser extent than the other suspended solids, particularly during the initial stages of the settling tests. This might imply lower zeolite type A removals in hydraulically overloaded tanks compared to suspended solids removal. (Baker-IVI) W84-02978

LEAD IN DRINKING WATER-INVESTIGA-TION OF A CORROSIVE WATER SUPPLY, Morris Township Health Dept., Convent Station

J. A. Benson, and H. Klein. Journal of Environmental Health, Vol. 45, No. 4, p 179-181, 1983. 1 Tab, 23 Ref.

Descriptors: \*Drinking water, \*Lead, \*Corrosion, Public health, Water quality, Potable water, Reservoirs, Pollutant identification, Hydrogen ion con-

A corrosive water supply in Morris County, New Jersey was investigated and appeared to result

from leaching lead out of solder in household plumbing systems. From June through November, 135 water samples were taken from 99 locations in the reservoir service area and analyzed. First flush the reservoir service area and analyzed. First nusa samples were taken the first thing in the morning, representing water that had been standing in the plumbing overnight. Standing grab samples were taken during the day without allowing the water to run first. Running grab samples were taken, and also composite samples, which were samples taken immediately before use of the water for drinking or cooking. Of the first flush samples 32% shows or immediately before use of the water for chimang, cooking. Of the first flush samples 32% showed lead levels in excess of 0.05 mg/l. Children living in these homes had on the average 14 micrograms/dl blood lead. In order to correct the problem the dl blood lead. In order to correct the problem the water authority sent notices out to customers to flush their plumbing systems out in the morning prior to use. In addition the pH of the water was raised from about 6.1 to 7.9 by lime addition. The water authority also began replacing the reservoir water with well water purchased from another nearby water authority. (Baker-FRC) W84-02983

RETROSPECTIVE ANALYSIS OF THE RE-SPONSE OF SAGINAW BAY, LAKE HURON, TO REDUCTIONS IN PHOSPHORUS LOAD-

Environmental Research Lab.-Duluth, Grosse Ile, MI. Large Lakes Research Station. For primary bibliographic entry see Field 5C. W84-03033

NEW WATER AND WASTEWATER SYSTEMS FOR ELLIOT LAKE, For primary bibliographic entry see Field 5D. W84-03100

CHLORINATION-FILTRATION FOR IRON AND MANGANESE REMOVAL.

RAYDOM MANGARESE REMOVAL, Raymond Kaiser Engineers, Inc., Oakland, CA. J. M. Wong. Journal of the American Water Works Associa-tion, Vol. 76, No. 1, p 76-79, January, 1984. 4 Fig, 2 Tab, 12 Ref.

Descriptors: \*Chlorination, \*Filtration, \*Iron, \*Manganese, Groundwater, Water treatment, Suspended solids, Cost analysis, Pilot plants.

Processes in which oxidation is followed by rerrocesses in which oxidation is tollowed by remove moval of suspended solids can effectively remove soluble iron and manganese from water. The common processes for removing iron and manga-nese are aeration-filtration, chlorination-filtration, and potassium permanganate-manganese greensand filtration. The potassium permanganate-manganese greensand filtration has an advantage in that the greensand can act as a buffer. The major disadvangreensand can act as a buffer. In emajor disadvan-tages of the aeration-filtration process are that the initial costs are high and if the soluble manganese concentration is greater than 1 mg/L, additional retention time and supplemental chemical treat-ment may be required. Chlorination-filtration soften slow and incomplete. At pH 8.4 and above the chlorination-filtration process effectively re-roves iron and manganese. The costs for oxidants moves iron and manganese. The costs for oxidants in chlorination-filtration are less than those for potassium permanganate-manganese greensand fil-tration. (Murphy-IVI) W84-03142

OVERLAND FLOW FOR IRON REMOVAL FROM POTABLE WATER, Clemson Univ., SC. Dept. of Agricultural Engi-

neering. J. Zirschhy, and L. Carlson. Journal of the American Water Works Associa-tion, Vol. 76, No. 1, p 80-83, January, 1984. 4 Fig.

Descriptors: \*Overland flow, \*Iron removal, \*Po-table water, Water treatment, Groundwater, Heavy metals, Iron, Water reclamation, Chemical degradation.

Overland flow, an effective wastewater treatment process, can be used for potable water treatment. Many groundwaters contain excessive amounts of

ferrous iron that result in a water of poor aesthetic quality. The natural reaeration that occurs during overland flow oxidizes ferrous iron to the more insoluble ferric form. The resulting precipitate then settles on the slope. An existing overland flow treatment system in Salo, Finland, achieves 97% iron and manganese removal. The system has a capacity of 1ML/d. Iron-bearing groundwater is discharged at the top of a 100-m long, 17-degree, natural slope. At the bottom of the slope, the water infiltrates into sand and gravel recharge basins where any remaining iron precipitate is filtered from the runoff. There are few mechanical systems to require maintenance, supervision or energy. Removal of the precipitate from the surface of the recharge basins is required only once a year. (Murphy-IVI) ferrous iron that result in a water of poor aesthetic

THE OCCURRENCE OF ALUMINUM IN DRINKING WATER.

DRINAING WALEK, R. G. Miller, F. C. Kopfler, K. C. Kelty, J. A. Stober, and N. S. Ulmer. Journal of the American Water Works Associa-tion, Vol. 76, No. 1, p 84-91, January, 1984. 6 Fig, 13 Tab, 16 Ref.

Descriptors: \*Aluminum, \*Drinking water, Pota-ble water, Groundwater, Surface water, Water quity, Raw water, Municipal water, Coagulation, Iron, Alum.

Raw and finished water samples were collected from 186 water utilities five times throughout a year and analyzed for iron and aluminum content. The water samples were categorized by the supply source (ground, surface, or a combination of both), the type of water (raw, finished, or untreated distribution samples), and the type of coagulation used in the treatment process (aluminum sulfate, ferric chloride, other coagulants such as cationic polymers, or no coagulant). The samples were also categorized according to the 10 EPA regions and 4 population categories. In the few facilities that used iron as a coagulant, the concentrations of iron and aluminum decreased. When alum is used for coagulation, there is a 40-50% chance that the concentration of aluminum will increase above the congulation, there is a 40-50% chance that the concentration of aluminum will increase above the original concentration in raw water. Aluminum is also more likely to exist in surface waters than in groundwaters. (Murphy-IVI) W84-03144

CONTROL OF TRIHALOMETHANE PRECUR-SORS IN DRINKING WATER: GRANULAR ACTIVATED CARBON WITH AND WITHOUT PREOZONATION,

Louisiana Tech Univ., Ruston. W. H. Glaze, and J. L. Wallace. Journal American Water Works Association, p 68-75, February 1984. 15 Fig. 4 Tab, 20 Ref.

Descriptors: \*Drinking water, \*Trihalomethanes, Preozonation, Ozonation, Granular activated carbon, Water quality control, Water treatment.

In a pilot study that lasted 80 weeks, unozonated and ozonated waters were fed to granular activated carbon columns to compare the removal of trihalomethane formation potential by GAC treatrimanomethate rollmation potential by occured with that by ozone-GAC treatment. The results were comparable for these treatments. Preozonation before GAC adsorption did not have a dramatic effect on the removal of THM precursors, at least at the dosages used in this study, generally 2-3.5 mg/liter. The GAC columns outperformed the ozone-GAC systems in terms of cumulative TOC or THMFP removed. In terms of cumulative TOC or THMFP removed. In terms of percentage removal, however, the two trains performed almost identically. Natural organics were slightly less adsorbable and slightly more biodegradable after ozonation, making the ozone-GAC systems and GAC systems perform nearly the same. Optimization of the ozone dosage and the GAC reactivation regime should lead to enhanced microbiologic removal, which would extend the lifetime of GAC for THMFP removal. (Baker-IVI)

W84\_03369

### Field 5—WATER QUALITY MANAGEMENT AND PROTECTION

### Group 5F-Water Treatment and Quality Alteration

RELATIONSHIP OF NITRATE CONCENTRA-TIONS TO DISTANCE OF WELL SCREEN OPENINGS BELOW CASING WATER LEVELS, Geological Survey, Lawrence, KS. Water Re-

T. B. Spruill.

Water Resources Bulletin, Vol. 19, No. 6, p 977-981, December, 1983. 3 Fig. 2 Tab, 13 Ref.

Descriptors: \*Nitrates, \*Well water, \*Kansas, Well screens, Depth, Groundwater pollution, Unconsolidated aquifers.

Data from 54 wells in central and eastern Kansas developed in unconsolidated deposits of Quaternary age indicate that nitrate concentrations are inversely related to the depth of the well screen inversely related to the depth of the well screen opening below the water level in the well casing. Because this relationship was found to exist in an area of Nebraaks and in a large area of Kansas, the relationship is generally valid over a wide geographical area. In addition, the data indicate that the incidence of nitrate concentrations exceeding 45 mg/l and nitrate concentrations, in general, are significantly lower in water from wells with screens deeper than 25 ft below the water table in unconfined auufers or where screens are placed in screens deeper than 23 it colors the water table in unconfined aquifers or where screens are placed in deep confined aquifers. No concentrations of nitrate greater than 45 mg/l were in observed wells where screens were deeper than 60 ft below the casing water level. Placement of well screens as far casing water level. Placement of weil screens as far below the water table as possible in unconfined unconsolidated aquifers in Kansas, and possibly other areas of the Midwest, may be an effective measure in preventing undesirable nitrate concentrations in ground water supplies, particularly in areas where nitrate is a problem. (Author's ab-W84-03403

### 5G. Water Quality Control

TROUT-ZOOPLANKTON RELATIONSHIPS IN MEDICAL LAKE, WA, FOLLOWING RESTORATION BY ALUMINUM SULFATE TREAT-MENT.

Eastern Washington Univ., Cheney. Dept. of Biol-

Ogy. S. M. Knapp, and R. A. Soltero. Journal of Freshwater Ecology, Vol. 2, No. 1, p 1-12, March, 1983. 5 Fig. 3 Tab, 17 Ref.

Descriptors: \*Trout, \*Fish food organism, \*Medical Lake, \*Washington, \*Lake restoration, \*Aluminum sulfate, Eutrophic lake, Fish establishment, Trout farming, Lake fisheries, Water quality con-

After restoration by whole-lake applications of liquid aluminum sulfate, Medical Lake, Washington, received a total planting of approximately 31,000 fingerling rainbow trout (Salmo gairdneri) from 1978 to 1980. Prior to treatment the lake had been unable to support game fish. Post-treatment improvement in water quality and zooplankton standing crops permitted good trout survival and growth. Daphnia pulex comprised over 90 percent of the trout diet for most age classes and dominated the biometer of the 10 per classes. Size adequations of the trout diet for most age classes and domination and the biomass of the 0+ age class. Size-selective predation was apparent for D. pulex 1.75 mm in length or larger. Intensive predation by trout appeared to be eliminating D. pulex as an available food source, which may jeopardize the effectiveness of the lake restoration as grazing on phytoplankton standing crop might diminish. (Author's selection) abstract) W84-02960

THE 'DECADE OF THE ENVIRONMENT' IN

THE U.S.S.R.,
San Diego State Univ., CA. Dept. of Geography.
For primary bibliographic entry see Field 6G.
W84-02986

ADMINISTRATION LOSES ITS UMBRELLA AGAINST STANDFAST ACID RAIN POLICY, L. Mosher.

National Journal, Vol. 15, No. 31, p 1590-1591, July, 1983. 1 Fig.

Descriptors: \*Acid rain, \*Political aspects, Legislation, Federal jurisdiction, Governmental interrela-tions, Legal aspects, Sulfur dioxide, Nitrogen oxides, Auto emissions, Exhaust.

On June 27, 1983, a group of nine nationally known scientists urged action be taken against acid rain, arguing that the risk of further environmental damage far outweighted the risk of acting on limit-ed information, and that some of the information ed information, and that some of the information which had been requested by the government could never be supplied as the measurements needed for that information were not in use decades ago. A very major concern was over continuing damage to soil microorganisms caused by sustained acidification. However, response was slow in coming to this report. One basic problem is to determine how much sulfur dioxide emissions to reduce and where. Acid rain bills on Capitol Hill fall into three categories: those calling for more fall into three categories: those calling for more research, for reductions in sulfur dioxide emissions in the 31 state bordering on or east of the Mississippi River and for reduction of both sulfur dioxide and nitrogen oxides in all 48 states. There appears to be in increased political momentum building to support efforts to control acid rain. (Baker-IVI) W84-03000

PROVIDING WATER SUPPLIES AND SANI-TATION FOR THE DEVELOPING WORLD, For primary bibliographic entry see Field 6B. W84-03101

POSSIBLE MEASURES FOR THE RESTORA-TION OF LAKE SEMPACH (MOGLICHE MASSNAHMEN ZUR RESTAURIERUNG DES

SEMPACHERSEES), Eidgenoessische Anstalt fuer Wasserversorgung, Abwasserreinigung und Gewaesserschultz, Due-bendorf (Switzerland).

R. Gachter, D. Imboden, H. Buhrer, and P. Stadelmann

Schweizerische Zeitschrift Hydrologie, Vol. 45, No. 1, p 246-266, October, 1983. 13 Fig, 3 Tab, 14

Descriptors: \*Lake restoration, \*Phosphorus, \*Switzerland, \*Lake Sempach, Hypolimnion, Aer-ation, Siphoning, Primary productivity, Wastewater treatment, Pollution load.

Lake Sempach is situated in the central part of Switzerland some 15 km NW of Lucerne. Since 1954 average orthophosphate and total phosphorus concentrations have increased twenty and eight-fold respectively in Lake Sempach. As a consequence of increased primary production, pH values, supersaturation of oxygen, and differences in alkalinity between winter and summer increased in the epilimaion. The construction of wastewater purification plants which started in 1968 was insufficient to reduce the total phosphorus loading, although in 1977 58% of the population was conauthough in 1977 50% of the population was con-nected to wastewater treatment plants. The lake is not in steady state with its phosphorus loading and the net deposition rate of phosphorus is not linear-ly related to the phosphorus content of the lake. This implies that linear steady state one-box models are unsuitable to describe the phosphorus balance of this lake. To estimate the effects of balance of this lake. To estimate the effects of decreasing the phosphorus loading, hypolimnion aeration or hypolimnion siphoning, a nonlinear dynamic lake model is used. The model predicts that the defined water quality goals can only be achieved within the next 15 years if the external phosphorus loading is reduced by at least 50% and simultaneously lake-internal measures, such as hysmuttaneously laxe-internal measures, such as ny-polimnion aeration or hypolimnion siphoning are carried into effect. Siphoning is recommended in preference to aeration since this lake-internal meas-ure requires much less energy and maintenance. (Moore-IVI)

WHAT PRICE AN UMBRELLA FOR ACIDIC P. Capes

Process Engineering, Vol. 64, No. 5, p 29, 31-32, May, 1983. 1 Fig. 1 Tab.

Descriptors: \*Acid rain, Sulfur dioxide, Industrial wastes, Powerplants, Water pollution control, England, Scandinavia, Fuels, Desulfurization.

As the principal source of atmospheric sulfur dioxide in the United Kingdom, it is likely that power ide in the United Kingdom, it is likely that power stations would have to bear the brunt of any emission cuts resulting from current international discussion. The head of the CEGB's environmental section points to the absence of unequivocal evidence to suggest that the effects on Scandinavian forests are directly associated with sulfur dioxide emissions. The weight of the issue going against the CEGB is reviewed. To cut its own emissions by 30%, the CEGB would need to convert six fossil fuelled stations. Overall United Kingdom reductions of 30% would require that the Board convert a further four stations. Flue gas desulfurireductions of 30% would require that the Board convert a further four stations. Flue gas desulfuri-zation, however, is not the only option available to CEGB. Pre-combustion washing of selected types of steam coal, selective importation of low-sulfur oil fractions are all possibilities. (Baker-IVI) W84-03366

USE OF DISSOLVED OXYGEN MODELING RESULTS IN THE MANAGEMENT OF RIVER

Geological Survey, Reston, VA. D. A. Rickert.

Journal of the Water Pollution Control Federation, Vol. 56, No. 1, p 94-101, January, 1984. 8 Fig, 2 Tab, 14 Ref.

Descriptors: \*Water quality control, \*Dissolved oxygen, \*Model studies, Management, Planning, Water management, Willamette River, Oregon,

The dissolved oxygen (DO) regime was examined in the Willamette River, Oregon from 1973-1974 during which time a mathematical model was calibrated, verified, and used to project the effects on DO of a wide range of pollution loadings and flow conditions. Future achievement of DO standards in conditions. Future achievement of DO standards in the Willamette River will require continued augmentation of summer low flows in addition to pollution control. Point-source loading of ammonia is the major cause of oxygen depletion in the modeled segment of river. Although DO levels in Portland Harbor are currently above the state standard, removal or partial reduction of a localized benthic demand would improve summer DO concentration. BOD loading from municipal wastewater treatment plants presently exerts a relatively small impact on DO. For the foreseable future, there is no need for municipal, advanced waste treatment to protect DO levels in this river. Maintenance of a minimum low flow of 170 cubic Maintenance of a minimum low flow of 170 cubic meters/second and reduction of industrial ammonia loading are the important management needs. (Baker-IVI) W84-03430

### 6. WATER RESOURCES PLANNING

### 6A. Techniques Of Planning

INTEGRATED RISK AND UNCERTAINTY AS-SESSMENT IN WATER RESOURCES WITHIN A MULTIOBJECTIVE FRAMEWORK,

Case Inst. of Tech., Cleveland, OH. Center for Scale Systems and Policy Analysis

Journal of Hydrology, Vol. 68, p 405-417, 1984. 37 Ref.

Descriptors: \*Water resources development, \*Risks, Water management Management, \*Risks, Water management, Management, I sion making, Planning, Probability distribution

The process of risk-and-uncertainty ass water resources is examined using a multiobjective framework. Appropriate methodologies such as the surrogate worth trade-off (SWT) method, the multiobjective statistical method (MSM), the partitioned multiobjective risk method (PMRM), the risk dispersion index method (RDIM), and the

### **Evaluation Process—Group 6B**

uncertainty sensitivity index method (USIM), are uncertainty sensitivity index memord (oSiM), are discussed briefly. A need for an approach that integrates the assessment of risk and uncertainty within a multiobjective framework is suggested, accounting for random variables with both known and unknown probability distributions. (Baker-IVI) W84-03352

### OPTIMIZATION OF A TREE-LIKE WATER-

SUPPLY SYSTEM, Edok-Eter-Mandilas Ltd., Athens (Greece). S. J. Kareliotis. Journal of Hydrology, Vol. 68, p 419-429, 1984. 2 Fig, 5 Tab, 4 Ref.

Descriptors: \*Optimization, \*Water conveyance, Systems analysis, Optimum development plans, Resources development, Planning, Water supply,

The construction of water-supply schemes involves significant amounts of capital investment and therefore their planning in selecting the optimum layout constitutes a very important part in the process between their conception and the final the process between their conception and the final execution of the project. An optimization method for the design of a tree-like water-supply system is presented. The system is divided into stages for a dynamic programming formulation and the state variables are defined to be pipe piezometric heads. The separation into stages is such that, for a given state, the optimum return is determined by applying linear expressmine. The extinguist defined as state, the optimum return is determined by apply-ing linear programming. The optimum is defined as the minimum total cost of the system. The total cost consists of the cost of pumping equipment, pumping, storage reservoirs and the cost of pipes which can vary according to the pressure strength requirements. The developed approach is applied to an example water-supply system, where the estimate of the minimum total annual cost of the system is the objective. The example system solved and its dynamic programming formulation had a and its dynamic programming formulation had a serial structure. Other systems with more than one source and/or elevated tanks and booster stations source and/or elevated tains and booster stations not in a series can be treated similarly by applying the dynamic programming technique for nonserial systems. The computation of the optimum for any given system can be performed very rapidly when a general linear programming program is available, since a computer solution of the mathematical equation of dynamic programming is not a difficult task. (Baker-IVI)
W84-03353

# SOME MATHEMATICAL PROBLEMS IN OP-TIMIZED PLANNING OF A WATER-RE-SOURCES SYSTEM, East China Technical Univ. of Water Resources, Nanjing. Dept. of Hydrology.

Y. Bingru. Journal of Hydrology, Vol. 68, p 431-442, 1984. 4 Fig, 5 Ref.

Descriptors: \*Optimization, \*Water resources development, Systems analysis, Planning, Mathematical equations

The optimized planning of a water-resources system is usually carried out through constructing a mathematical model of the system, and is solved by systems analysis or methods of mathematical programming. For a general deterministic linear programming problem, the constraint condition usually consists of three types, viz. two kinds of inequality equations, and another of equality constraints. In solving such a problem with the Simplex method, usually some relaxation variables are introduced in order to find the initial feasible basic solution, as well as to reduce the mathematical solution, as well as to reduce the mathematical solution, as well as to reduce the mathematical model having inequality constraints, to the standard form of LP. A general method of generating the non-inferior set in multi-objective programing is also proposed. The idea of using the two-dimensional decomposition method is discussed and numerical examples are given for illustration. (Baker-IVI)

# RURAL WATER-SUPPLY AND SANITATION PLANNING: THE USE OF SOCIOECONOMIC

PRECONDITIONS IN PROJECT IDENTIFICA-TION, CDM-WASH Project, Arlington, VA.

Journal of Hydrology, Vol. 68, p 443-459, 1984. 2 Fig, 16 Ref.

Descriptors: \*Planning, \*Water supply development, \*Sanitation, Rural areas, Socioeconomic factors, Developing countries.

Recognition of the socioeconomic preconditions for successful rural water-supply and sanitation projects in developing countries is the key to iden-tifying a new project. The socioeconomic aspects of preconditions in the context of a five-step proce-dure for project identification are discussed. The dure for project identification are discussed. The procedure includes problem identification, determination of socioeconomic status, technology selection, utilization of support conditions, and benefit estimation. While the establishment of specific preconditions should be based on the types of general relationships regarding favorable preconditions in water and sanitation planning are outlined. These relationships are used within the five step procedure to develop a set of general guidelines for the application of preconditions in the identification of rural water-supply and sanitation projects. (Baker-IVI)

# A BINARY STATE DP ALGORITHM FOR OP-ERATION PROBLEMS OF MULTIRESER-VOIR SYSTEMS, Syracuse Univ., NY. Dept. of Industrial Engineer-ing and Operations Research. M. Ozden.

Water Resources Research, Vol. 20, No. 1, p 9-14, January, 1984. 3 Fig, 1 Tab, 11 Ref.

Descriptors: \*Operating policies, \*Reservoirs, Algorithms, Mathematical studies, Management, Decision making.

Reservoir operation problems are complicated by the nonlinearities in the objective functions. The dynamic programing (DP) procedure is often used to solve this problem because of the sequential nature of the decisions involved, but for simultanenature of the decisions involved, but for simultaneous operations of multireservoir systems, other DP-based techniques are frequently found to be more efficient in overcoming the curse of the dimensionality problem caused by the interdependencies of the decisions. The DP-based procedure proposed performs better than other well-known techniques. The applications of this technique are presented in two different formulations for four-reservoir operation problems. The convergence properties of the algorithm are investigated as revealed from the systematic solutions of a control problem with various dimensions. The procedure enables the solution of moderately large systems within a reasonable computation time for the operwithin a reasonable computation time for the oper-ation of multireservoir systems. (Baker-IVI) W84-03407

### 6B. Evaluation Process

# THE ALTAMIRA HYDRO COMPLEX IN THE

AMAZON REGION, A. T. Duarte, J. L. Pettena, and J. da Rocha Paes Filho.

International Water Power and Dam Construction, Vol. 35, No. 10, p 23-28, October, 1983. 5 Fig. 5

Descriptors: \*Dam construction, \*Energy, \*Brazil, \*Altamira Hydro Complex, Powerplants, Construction, Design criteria, Planning, Evaluation, Economic aspects.

Principal results are given of the Hydroelectric Inventory Studies of the Xingu river basin, in the Amazon region of Brazil. The potential for installed capacity was more than 20,000 MW at an average cost of about US\$1000/kW, realized with a maximum of seven sites developed at various drops along the river. At the two downstream developments which constitute the Altamira com-

plex, it is possible to develop more than 14,000 MW of installed capacity at a cost of about US\$750/kW. The lack of centers for local con-USS/30/kW. The lack of centers for local consumption and the large amount of energy which can be produced from the hydrocomplex of Altamira, mean that the tendency will be to export this energy in the future to other regions in Brazil in need of supplies. Based on current estimates the transmission costs of energy generated at the complex for the three load factors considered in the preliminary studies reveal them to be very attractive as they do not exceed US\$7/MWh. (Baker-IVD W84-02995

### MAGAT RIVER MULTIPURPOSE PROJECT. National Irrigation Administration, Quezon City (Phillipines). B. V. Viola, and V. C. Wilhelm.

International Water Power and Dam Construction, Vol. 35, No. 12, p 17-23, December, 1983. 3 Fig. 4 Tab. 5 Ref.

Descriptors: \*Dam construction, \*Design criteria, Flood control, Magat River, Philippines, Water resources development, Planning, Decision making, Evaluation, Typhoons, Earthquakes.

making, Evaluation, Typhoons, Earthquakes.

Basic design considerations, construction methods and the principal features of the Magat multipurpose development in the Philippines are discussed. The system will irrigate 102,000 ha of ricelands and generate 360 MW of power. Several factors played an important role in determining the location and the basic features of the Magat project. Bagabag, a large town in the potential reservoir area with a population of over 30,000 was, by government decision, not to be moved, thus restricting the elevation. High sedimentation rates called for extra storage to maintain the useful life of project. Other factors included the high seismicity of the area and the very high flood runoffs. Since the dam site itself is traversed by several faults which are considered potentially active, the structures had not only to be designed for high ground acceleration, but also for possible offset conditions. The Magat watershed is adjacent to the Baguio meteorological station. Typhoons create almost unbelievable runoffs and the Magat river, which at the dam site thas an average flow of about 200 cu m/sec, has experienced a flood flow of 20,000 cu m/sec, has experienced a flood flow of 20,000 cu m/sec, has experienced a flood flow of 20,000 cu m/sec. The maximum inflow should be in the order of 34,500 cu m/sec. A spillway design capacity of 30,800 cu m/sec was planned. (Baker-IVI)

## DEVELOPMENT OF WATER RESOURCES IN

Industrial Sites and Water Resources Development Corp., Seoul (Korea). J. C. Kim.

J. C. Kim. International Water Power and Dam Construction, Vol. 35, No. 12, p 23-25, December, 1983. 3 Fig, 3

Descriptors: \*Water resources development, \*Dam construction, \*Korea, Reviews, Water demand, Energy, Powerplants, Chungju Dam, Environmen-tal effects, Government sunports cts, Government supports.

Korea has built enough dams to store 20% of the annual average runoff during the past 20 years. The Korean agriculture is based primarily on rice. Farmers begin planting in early April and harvest in October. Traditionally Koreans built small ponds and earth dams near their paddy fields so that the storage might cover the dry season for three months from April through June. Things began to change in 1945 with the Japanese invasion of Korea. The Japanese built higher earth dams so as to grow more rice for export to Japan and they began building high concrete dams incorporating began building high concrete dams incorporating hydro powerplants to provide industries with energy for manufacturing strategic materials for invading China. After the Korean war the country could not afford large investments in exploiting water power. A shift from light industry to heavy chemical manufacture in the 1960s brought about a power shortage and an increase in the demand for

### **Group 6B—Evaluation Process**

water. South Koren has a total land area of about water. South Korea has a total land area of about 99,000 sq. km and an average annual precipitation of 1160 mm yielding a potential water resource of 114 x 10 to the 9th power cum. Plans are underway to build the Chungju multipurpose dam, 97.5 m high with a storage capacity of 2.75 x 10 to the 9th power cu m bringing the current total storage capacity to 13.1 x 10 to the 9th power cu m. Environmental protection is being emphasized by the government and the government now requires an environmental survey before any civil engineer-ing project is undertaken. (Baker-IVI) W84-02990

A TIME SERIES APPROACH TO FORECAST-ING ANGLING ACTIVITY AT A RECRE-ATIONAL SITE BASED ON PAST SUCCESSES, Minnesora Univ. Dublish, Depart SUCCESSES,

Minnesota Univ.-Dulub. Dept. of Economics. D. N. Steinnes, and R. L. Raab. Canadian Journal of Fisheries and Aquatic Sciences, Vol. 40, No. 12, p 2189-2193, December, 1983.

Descriptors: \*Time series analysis, \*Forecasting, \*Recreation, \*Fishing, Fish management, Conservation, Mathematical models, Model studies, Model testing, Regression analysis, Cost analysis.

A multiple regression model was developed for estimating or forecasting the impact of past fishing 'successes' on the current angling activity or par-ticipation at a recreational site. The time series methodology is useful as a forecasting tool by methodology is useful as a forecasting tool by investigating the lag structure of success and measuring its elasticity. The evaluated empirical results were based on daily time series data for Lester River, a Lake Superior river. The river was surveyed in Duluth, Minnesota in 1977 during the spring steelhead run on a regular basis to collect a systematic sample of 33 days during 2 months. The anglers respond more to past total success at the site than to past success per unit of effort at the site. The model could be extended to estimate the economic value of catching a fish. An extended model would be part of a comprehensive approach model would be part of a comprehensive approach for valuing changes in habitat by using benefit-cost analysis with it. (Murphy-IVI) W84-03024

APPRAISING WASTEWATER DISCHARGE

COMPLIANCE LEVELS,
Allied Chemical Corp., Morristown, NJ. Corporate Research Center E. J. Shields.

Pollution Engineering, Vol. 15, No. 7, p 33-37, July, 1983. 1 Fig. 3 Tab.

4

Descriptors: \*Wastewater disposal, \*Monitoring, Compliance, Water analysis, Planning, Manage-

Appraisals made of the compliance performance of wastewater discharging facilities made to date have largely been qualitative in nature, consisting of subjective evaluations which frequently use on supervive evaluations which irequently use mon-precise terms such as serious, substantial and significant to describe the levels of non-compliance that exist. A more meaningful technique for evaluating the performance of a facility in maximizing the compliance levels achieved by their wastewater dischargers would provide manage-ment with a useful control tool. The technique ment with a useful control tool. The technique should provide a uniform approach for appropri-ately weighing frequency of excursions, pollutant parameters involved, degree to which the dis-charge limitations are exceeded, duration of the excursions, and the exposure to excursions posed by the amount of required testing. A description of the Allied Chemical Program which uses such a technique is presented. (Baker-IVI) W84-03047

NEW BUSINESS OPPORTUNITIES, Lorenz (William T.) and Co., Boston, MA. W. T. Lorenz.

Pollution Engineering, Vol. 25, No. 9, p 32-36, September, 1983.

Descriptors: \*Wastewater treatment, \*Economic aspects, \*Water treatment, Business opportunities,

Management, Decision making, Planning, Finan-cial aspects. Instrumentation, Water resources decial aspects, Instrumentation,

New business opportunities in the water field are developing including those related to the following areas: water resource planning, development of resources, water treatment, wastewater treatment, wastewater reuse and recycling, transmission and storage, instrumentation, the agricultural market, the government market, the industrial market and the government market, the industrial market and the private market. Package wastewater treatment plants have gained a strong foothold in the com-plex area of industrial wastewater treatment. There are about 100 United States companies supplying such equipment and the competition is fierce in this aspect of water treatment. The total wastewater and water instrumentation market in 1985 is ex-pected to reach \$325 million. (Murphy-IVI) W84-03050

CONTROLLING AGRICULTURAL SOIL LOSS IN ARKANSAS' NORTH LAKE CHICOT WA-TERSHED: AN ANALYSIS OF BENEFITS,

ARKANASI ANALYSIS OF BENEFITS, Arkanasa Univ., Fayetteville. Dept. of Agricultural Economics and Rural Sociology. C. T. Osborn, and R. N. Shulstad. Journal of Soil and Water Conservation, Vol. 38, No. 6, p. 509-512, November-December, 1983. 2 Fig. 8 Ref.

Descriptors: \*Erosion control, \*Cost-benefit analysis, Water management, Recreation, Lakes, Financial aspects, Mathematical equations, Lake Chicot,

A unique environmental situation made it possible A unque environmental statution made it possione to estimate the recreational benefits of a soil erosion control project in the northern watershed of Lake Chicot, Arkansas. Using a discount rate of 7 and 3/8%, the estimated present value of benefits for the project over a 50 yr period is \$6.7 million. Compared with the estimated present value of for the project over a 50 yr period is \$67.7 million. Compared with the estimated present value of costs over the same period, \$600,000, it is clear, at least from an efficiency standpoint, that the proposed soil erosion control project is overwhelmingly justified. Lake Chicot is, in reality, two lakes, side-by-side, separated by a man-made levee. The southern lake had become sity and turbid, drastically diminishing its recreational value. The purpose of the erosion control program was to prevent the same loss of recreational value in the north lake. Mathematical equations were developed relating hours per visit to travel cost, on-site cost, income, investment in recreational equipment. cost, income, investment in recreational equipment, cost, income, investment in retreatment equipment, number of visits per year, number in parts, and age. These equations were developed for each basin of the lake. When all the information was gathered, dividing the present value of benefits for the program by the present value of costs yields a benefit-cost ratio of 112, which clearly justifies the undertaking of the proposed soil erosion control pro-gram. (Baker-IVI)

PROVIDING WATER SUPPLIES AND SANITATION FOR THE DEVELOPING WORLD,

Water and Pollution Control, Directory and Buyers' Guide, Vol. 121, No. 6, p 20-25, November, 1983. 4 Fig.

Descriptors: \*Water supply, \*Developing countries, \*Sanitation, Wastewater, Drinking water, Planning, Evaluation, Decision making, Public

The United Nations declared the 1980s to be the International Drinking Water Supply and Sanitation Decade in which the goal was to provide safe drinking water and adequate sanitation to all people by 1990 for reasons of public health. A WHO survey listed manpower and finances as the two greatest restraints to meeting the goal. Canadian consultants who have started work overseas understand that the commitment to devising and maintaining high quality sanitation and water supply systems in a developing country requires trained personnel. One major problem area lies in the training of local personnel in the maintenance of whatever improvements are made. The installa-

tion of shiney new equipment is not necessarily the only nor the best answer to the problems that exist in these developing nations. (Baker-IVI) W84-03101

CLEANER TECHNOLOGY: WHO FROM POLLUTION PREVENTION,

J. Elkington. Process Engineering, Vol. 64, No. 5, p 24-26, May, 1983. 1 Fig, 1 Tab, 11 Ref.

Descriptors: \*Industrial wastes, \*Planning, Water pollution prevention, Management, Decision

The current status of clean technology is reviewed. Responses to a major industrial pollution problem include doing nothing and allowing the problem to continue unabated, closing the factory or plant, continuing discharging but in such a way that pollution is minimized, installing pollution control systems to remove the pollutants, develop and deploy cleaner and low waste technologies, and promote structural changes in the local, regional, or EFC company Last wear the first batch of promote structural changes in the local, regional, or EEC economy. Last year the first batch of United Kingdom entries joined the UN Economic Commission for Europe's Compendium on Low and Non-Waste Technologies. The challenge is for Government and for the public sector agencies to ensure that the appropriate technologies are made available, by whatever route, to medium and small companies. (Baker-IVI)

ESTIMATING RESIDENTIAL FLOOD CONTROL BENEFITS USING IMPLICIT PRICE EQUATIONS,

Union Pacific Railroad, Omaha, NE. For primary bibliographic entry see Field 4A. W84\_03392

MISSOURI RIVER - THE NEW COMPACTING

M. F. Harris

Water Resources Bulletin, Vol. 19, No. 6, p 921-927, December, 1983. 4 Tab, 19 Ref. Northwest Area Foundation grant 785-0144A.

Descriptors: \*River basins, \*Water use, Missouri River, Interstate agreements, Water management, Water demand, Water resources development.

Proposed interbasin water diversions of the Missouri River are related to energy development, agricultural, municipal, and industrial water use. Overall, an estimated 8.5 million acre-feet of water Overait, an estimated as minion actrice of water from the Missouri River could be diverted by the year 2000 if three major projects are allowed to take place or continue. Interstate issues in the river basin include interbasin water diversions, riverbed and shoreline degradation, loss of recreational and natural areas, reduction in navigation capacity, the status of the Pick-Sloan Missouri Basin Program in status of the Pick-Stoan Missouri Basin Program in terms of general river development, and the elimi-nation of river basin commissions. An attempt to develop a comprehensive interstate water compact failed in the 1950s. Much of the concern over general river development lies in differing individ-tual state attitudes towards the Dick Stoan Missouri ual state attitudes towards the Pick-Sloan Missouri Basin Program. But, there are other available mechanisms for the resolution of the current political and legal differences among the ten river basin states. (Murphy-IVI)

### 6C. Cost Allocation, Cost Sharing. Pricing/Repayment

MODELS FOR WATER WASTEWATER PLANNING, REUSE AND MODELS

California State Water Resources Control Board, Sacramento. For primary bibliographic entry see Field 5D.

W84\_03001

### Water Law and Institutions—Group 6E

FUNDING MUNICIPAL WASTEWATER FA-CILITIES IN GEORGIA, J. L. Ledbetter, J. C. Dozier, and W. K. Jordan. Current Municipal Problems, Vol. 10, No. 2, p 206-212, Fall, 1983. 1 Tab.

Descriptors: \*Grants, \*Wastewater treatment fa-cilities, Georgia, Economic aspects, Water pollu-tion control, Industrial wastes, Municipal wastewater, Clean Water Act, Government fi-nance, State jurisdiction, Construction Grants Pro-

The Clean Water Program in Georgia is reviewed and updated. The principal sources of water pollution in that state are industries and publicly owned wastewater treatment works, with the latter being the more difficult to control, due more to lack of sufficient funds than to technical problems. The the more difficult to control, due more to lack of sufficient funds than to technical problems. The State has received about \$610 million over the ten year history of the Construction Grants Program. There are approximately 67 wastewater treatment facilities that have been completed and were upgraded or totally constructed with monies appropriated under the Clean Water Act (PL 92-500). Additional funds are needed to insure that the momentum which has built up in the program will be maintained. However, serious reductions in funding levels for the State have made it clear that many of the communities currently involved in planning and design activities may never receive funding for the actual construction of needed facilities through the Construction Grants Program. (Baker-IVI)

ESTIMATING DEMAND FOR INTAKE WATER BY SELF-SUPPLIED FIRMS, Arkansas Univ., Fayetteville. Bureau of Business and Economic Research. J. A. Ziegler, and S. E. Bell. Water Resources Research, Vol. 20, No. 1, p 4-8, January, 1984. 3 Tab, 30 Ref.

Descriptors: \*Water demand, \*Pricing, Water supply, Industrial water, Water use, Statistical analysis, Economic aspects.

In many instances, heavy water-using firms use water from a self-supplied source such as a nearby lake, river, or well and do not purchase if from any private or public source. While these firms pay for the acquisition, treatment, and disposal of water, they do not pay a price determined in the market through the interaction of independent buyers and sellers but rather a price which reflects only firm costs and demands. The idea that there is no significant difference in the estimates of industrial water demand schedules when using either average or demand schedules when using either average or marginal cost as a proxy for price was examined. marginal cost as a proxy for price was examined. Water usage and cost information were obtained from questionnaires sent to paper and chemical plants in Arkansas, and two demand functions for intake water were calculated. F tests were performed to determine if each price variable made a significant contribution to its respective model. In addition, adjusted R(2), Mallow's statistic, and the PRESS statistic were calculated to determine best statistical fit and predictive capability. The findings indicated that both price variables made statistically significant incremental contributions to their respective models but that the model using AC explained a larger percentage of variance about the mean and was a better predictor. This relationship may change in the future as water becomes relamean and was a better predictor. Ints relationsing may change in the future as water becomes relatively more expensive and a larger part of total production costs. These circumstances may result in firms becoming more responsive to marginal water costs. (Baker-IVI) W84-03406

### 6D. Water Demand

U.K. PUSHES R AND D TO MEET POTABLE WATER DEMAND,

Consulting Engineer, Vol. 61, No. 5, p 72-73, November, 1983.

Descriptors: \*Water supply development, \*United Kingdom, \*Potable water, \*Water demand, Ni-

trates, Organic compounds, Lead, Drinking water, Plumbing, Water quality control.

Problems in the United Kingdom concerning water are similar to those in the United States: new towns and industrial estates must be supplied with water. and. simultaneously, old systems must be towns and industrial estates must be supplied with water, and, simultaneously, old systems must be replaced or repaired. Public concern in the United Kingdom is mounting over trace organics and inorganics in the water supplies. Lead in potable water is a risk for the estimated 40% of the British people who still have lead plumbing. Nitrate concentrations in ground and surface waters are increasing. The total supply itself was shown to be a quickly reduced to a dangerously low level following the summer drought in 1976. Efforts are underway to increase the supply. (Baker-IVI)

CASCADE MODEL OF MONTHLY MUNICIPAL WATER USE,
Texas Univ. at Austin. Dept. of Civil Engineering.
D. R. Maidment, and E. Parzen.
Water Resources Research, Vol. 20, No. 1, p 1523, January, 1984. 5 Fig. 2 Tab, 28 Ref. Texas
Dept. of Water Resources contract 14-10044.

Descriptors: \*Water use, \*Municipal water, Mathematical models, Climate, Seasonal variation, Autocorrelation, Probability, Canyon, Texas.

A time series model of monthly mur A time series model of monthly municipal water use is formulated as a set of equations representing the effects of four factors on water use: trend, seasonality, autocorrelation, and climatic correlation. The parameters of these equations are found by passing the water use time series through a cascade of four transformations; in each transformation the parameters of an equation associated with one factor are statistically determined and the series transformed to remove the effects of this factor. After the last transformation, only a random error series remains. Monthly municipal water use at Canyon, Texas, from 1961-1978 is icipal water random error series remains. Monthly municipal water use at Canyon, Texas, from 1961-1978 is modeled as an example. The model explains 86% of the variance of this series, divided among the four factors as trend (29%), seasonality (44%), autocorrelation (2%), and climatic correlation (11%). The random error is shown to be normally distributed by a nonzeropstric procedure. distributed by a nonparametric procedure charac-terizing probability families by their density quan-tile functions. (Author's abstract) W84-03408

### 6E. Water Law and Institutions

FISHING RIGHTS: INDIAN FISHING RIGHTS AND CONGRESS: THE SALMON AND STEEL-HEAD CONSERVATION AND ENHANCE-MENT ACT OF 1980, J. P. Mentor, Jr. American India Law Review, Vol. 9, No. 1, p 121-

Descriptors: \*Fishing, \*Legal aspects, \*Indian fishing rights, \*Salmon, \*Steelhead, Commercial fishing, Sport fishing, Pacific Northwest.

The Salmon and Steelhead Conservation and En-The Salmon and Steelhead Conservation and Enhancement Act of 1980 was passed to prevent the depletion of the salmon and steelhead resource of the Pacific Northwest. However, the act leaves unresolved the status of commercial fishing for steelhead, and thus does little to ease the tension between Indians and non-Indian sports fishermen. The Act does not preclude future abrogation of Indian treaty fishing rights. The Act establishes a coordinated commercial entity. Indian treaty fishing rights. The Act establishes a coordinated, comprehensive management entity, the Salmon and Steelhead Advisory Commission, provides funding for both state and tribal enhancement projects, and provides for the purchase of non-Indian commercial fishing and charter vessels and their licenses by the state. The most significant contribution of the Act is the adoption of a comprehensive management plan. (Baker-IVI) W84-02975

WATER RIGHTS: ABORIGINAL WATER USE AND WATER LAW IN THE SOUTHWESTERN

UNITED STATES: WHY THE RESERVED RIGHTS DOCTRINE WAS INAPPROPRIATE.

American Indian Law Review, Vol. 9, No. 1, p 195-209, 1983. 54 Ref.

Descriptors: \*Water rights, \*Legal as \*Indian water rights, Aboriginal title, Ri-rights, Property rights, Southwestern U

Whether the Indians of the Southwest ought to have received aboriginal title to water rights by way of their existing use of the water is examined. The evolution of the doctrine of aboriginal title is discussed and the Winters doctrine of reserved rights is explored. The evidence of the native cultural traditions is surveyed to determine if aboriginal rights should have been acknowledged, or whether the Winters doctrine gave the Indians water rights previously unearned under common law. (Baker-IVI)
W84-02976 W84-02976

THE THIRD WAVE IN WATER QUALITY MANAGEMENT,

R. J. Foxen. Civil Engineering, (New York), Vol. 53, No. 4, p 43-45, April, 1983.

Descriptors: "Cost-benefit analysis, "Tertiary wastewater treatment, "Water quality management, "Water law, "Future planning, Capital costs, Cost analysis, Benefits, Secondary wastewater treatment, Water quality control, Water quality standards."

In the 1970's, there was great public pressure on the Environmental Protection Agency (EPA) to clean up water polluting discharges by methods of advanced wastewater treatment (AWT), no matter what the cost. In response to this pressure, Congress passed the Clean Water Act in 1972, which fostered adoption of AWT technology to improve water quality. A review of some AWT projects of the 1970's showed that some of them were not very cost effective. EPA funding was subsequently denied for some projects that would do little to improve water quality but would require great capital expenditures. Many groups have questioned the legality of AWT project reviews, stating that environmental impact and not cost savings should be the area of major concern. An amendment to the Act in 1966 (301h) allowed less than secondary treatment to marine wastewater discharges if it could be proven that minimum water quality standards would not be violated. In the early 1980's, increased demands to lessen government spending and increased burdens on taxpayers caused decreased local funds to finance AWT projects. The 301h waiver could be used in the future to meet minimum water quality tandards in certain areas and provide more stringent AWT requirements only in areas where needed to procertain areas and provide more stringent AWT requirements only in areas where needed to promote economic efficiency by better use of public funds. (Geiger-FRC) W84-02980

SPORHASE V. NEBRASKA EX REL. DOUGLAS: A CALL FOR GROUND WATER LEGISLATION,

J. M. Cran Denver Law Journal, Vol. 60, No. 4, p 631-643, 1983, 124 Ref.

Descriptors: \*Groundwater, \*Legal aspects, \*Ne-braska, \*Legislation, Water export, Water import, Interstate commerce.

The Supreme Court, in its decision in the case of Sporhase vs Nebraska ex rel. Douglas, held that state water anti-export statutes are contrary to the commerce clause of the federal Constitution. This decision brings water regulations within the scope of the Court's previous pronouncements on state statutes regulating interstate commerce in animal, vegetable, and mineral resources. The develop-ment of the commerce power is outlined as it relates to state export/import restrictions, and the Court's rational in this decision in the context of

### Field 6-WATER RESOURCES PLANNING

### Group 6E-Water Law and Institutions

commerce clause precedent is examined. The Court's characterization of water is analyzed, and probable effects of this holding on future interstate water allocation plans will be projected. This comment takes the position that some state regulation of groundwater export is possible after Sporhase. (Baker-IVI) W84-03003

WHEREVER THE WATER FLOWS: LYON AP-PLIES THE PUBLIC TRUST TO NON-TIDAL

B. Seldon Ecology Law Quarterly, Vol. 11, No. 1, p 21-45, 1983. 145 Ref.

Descriptors: \*Public trust doctrine, \*Land use, \*Shores, Legislation, Legal aspects, California, Lakes, Rivers, Swamps, Wetlands.

Lands between high and low watermarks along the shores of all navigable water in California are subject to the public trust. Some of the land is subject to the public trust even though it was subject to the public trust even though it was patented as swamp and overflowed land. Many of the lands subject to the trust have been filled or improved despite their trust status. The more equitable way to deal with these lands is to balance the interests of the public and the landowner on a case-by-case basis, as the California Supreme Court directed with tidelands in City of Berkeley. The uncertain nature of trust purposes and their tenden-cy to conflict with each other lead to uncertain cy to continct with each other lead to indertain expectations among landowners affected by the public trust. Some of this uncertainty could be dispelled by regional planning, which would give each landowner an indication of what used he may make of his property without being found in con-flict with a trust purposes. (Baker-IVI) W84-03004

EQUITABLE DISCRETION UNDER THE FED-ERAL WATER POLLUTION CONTROL ACT: WEINBERGER V. ROMERO-BARCELO,

California Univ., Berkeley. School of Law. J. Petruzzi, and M. Thomas. Ecology Law Quarterly, Vol. 11, No. 1, p 73-94, 1983. 192 Ref.

Descriptors: \*Water pollution control, \*Water Pol-lution Control Act, \*Puerto Rico, Coastal waters, Equitable discretion, Legal aspects, Navy, Permits, Fiftherits.

Congress substantially amended the Federal Water Pollution Control Act (FWPCA) in 1972 to provide for a detailed permit system establishing individual compliance schedules for effluent discharge sources. United States Navy training in Puerto Rico has since 1970 been responsible for dumping much material into the coastal waters surrounding that island. Eventually the Supreme Court became involved in light of the statutory background of the FWPCA and case law concerning federal court exercise of equitable discretion. The text and legislative history of the Act require that a permit be obtained prior to the discharge of pollutants into navigable waters. In addition, previous Supreme Court decisions suggest that federal courts are without power to allow an ongoing violation of a statutory command. The Romero-Barcelo decision greatly changes the comprehensive regulatores. cision greatly changes the comprehensive regulatory program devised by Congress. That decision permitted the Navy to continue its discharges without a permit or a Presidential exemption. This decision may have the unfortunate consequence of encouraging violators of the Act to wait until they are sued before applying for a permit. (Baker-IVI)

MANAGING AGRICULTURAL POLLUTION, Pennsylvania Univ., Philadelphia. Dept. of City and Regional Planning. J. C. Keene.

Ecology Law Quarterly, Vol. 11, No. 2, p 135-188, 1983. 2 Tab, 327 Ref.

Descriptors: \*Water pollution control, \*Agricul-ture, Legal aspects, Legislation, Common law nui-sance, Nuisance, Farm wastes, Land use.

Several major approaches to managing agricultural pollution are reviewed, including judicial resolution of land use conflicts based on principles of common law nuisance; recent legislative attempts to limit the application of those principles by the enactment of right-to-farm laws; technology-forcing regulation; and spatial separation of agricultural activities from land uses with which they conflict, by the creation of agricultural districts or comprehensive farmland protection programs. The essence of the law of private nuisance is that it involves the application of a set of general principles to a particular set of circumstances. The court must decide whether there is a substantial interference, whether the social value of one activity ence, whether the social value of one activity outweighs that of another, which of two uses is more appropriate for a particular neighborhood, and whether the harm can be either avoided or and whether the narm can be either avoided or prevented at relatively little cost. The strengths of this process are that a landowner can do what he wants with his property so long as he does not interfere unreasonably with the rights of his neigh-bor, and that landowners can take advantage of developments in technology. (Baker-IVI) W84-03006

SPORHASE V. NEBRASKA: THE MUDDYING OF COMMERCE CLAUSE WATERS,

California Univ., Berkeley. School of Law. A. D. Greenberg. Ecology Law Quarterly, Vol. 11, No. 2, p 215-239, 1983. 176 Ref.

Descriptors: \*Legislation, \*Ownership of water, Federal jurisdiction, Regulations, States rights, Water law, Water transfer.

The Sporhase opinion and the validity of state The Sporhase opinion and the validity of state efforts to regulate interstate transfers of water are examined. Discussions center on the development of the state ownership exemption from Commerce Clause analysis, the Sporhase opinion, and the decision. In Sporhase, the Supreme Court attempted to balance the Commerce Clause goal of national unity with the traditionally strong local interest in water resource regulation. Water law is most efficient when made at the local level, and is a legitimate exercise of the nolice power of the state. mate exercise of the police power of the state.

Thus each state determines its own water rights doctrines with little interference from the federal government. Neither the presence of detailed state regulatory programs nor the importance of the resource justifies a departure from standard consti-tutional analysis. The Court can recognize the tutional analysis. The Court can recognize the legitimacy of state water law by requiring all non-residents to comply with standards a state establishes for its citizens. Resident preferences justified on the grounds of conservation and preservation goals invite the strictest scrutiny of the court. By implying that courts may decline this invitation when reviewing water laws, the Supreme Court in Sporhase provided little guidance to those who must draft and enforce such laws, and added confusion to an already unsettled state ownership doctrine. (Baker-IVT)

SO ITS NOT 'OURS' - WHY CAN'T WE STILL KEEP IT; A FIRST LOOK AT SPORHASE V. NEBRASKA,

NEBRASAA, Chicago-Kent Coll. of Law, IL. A. D. Tarlock. Land and Water Law Review, Vol. 18, No. 1, p 137-174, 1983. 121 Ref.

Descriptors: \*Legislation, \*States rights, Ownership of water, Federal jurisdiction, Regulations, Nebraska, Water transfer.

The United States Supreme Court's decision in Sporhase v. Nebraska is examined. The implications the decision has for western states' attempts toons the decision has for western states' attempts to control their water resources are noted and a revision in the Court's approach to such questions is suggested. An approach is presented within the framework of Sporhase to export statutes that allows a state to assert its essential interests in determining the locus of water use. This effort is animated by the programmy argument that there is animated by the normative argument that there is no basis for federal preemption of state water law in this or any other energy issue. A process-based

approach is suggested for western water law such that it suggests a case against judicial interference in water allocation choices when the risks of a malfunction in the political process are low. To continue to allow the states to allocate their water resources, courts need to avoid formulation many hard and fast rules about the duty to share scarce waters among interested states. Existing principles of law provide a sufficient context for the political process to function to determine interregional equity issues. (Baker-IVI)

WETLANDS PRESERVATION, FISH AND WILDLIFE PROTECTION, AND 404 REGULA-

TIONS: A RESPONSE, Lewis and Clark Coll., Portland, OR. Natural Resources Law Inst

Land and Water Law Review, Vol. 18, No. 2, p 469-489, 1983. 112 Ref. NOAA grant NA 81AA-D-00086.

Descriptors: \*Legislation, \*Permits, \*Wetlands, \*Wildlife, Water pollution control, Clean Water Act, Regulations, Economic aspects, Legal as-

The permit program established by section 404 of the Clean Water Act is defended against the charges of bureaucratic red tape and over-regula-tion. The value of wetlands and fish and wildlife tion. In evalue or wettands and itsh and wildnite are viewed as warranting a broad 404 jurisdictional mandate and a pluralistic review process designed to assure that the benefits of aquatic developments exceed their costs. It is argued that the existing 404 program, grounded on widespread intergovernmental and public review, has both preserved important ecosystems and produced more cost-effec-tive developments. However, the wisdom and the legality of a recent expansion in the use of general permits is questioned and a number of suggestions to increase the effectiveness of the program are made. (Baker-IVI) W84-03009

SPORHASE V. NEBRASKA EX REL. DOUG-LAS: STATE CONTROL OF WATER UNDER THE CONSTRAINTS OF THE COMMERCE

A. B. Tallmadge. Land and Water Law Review, Vol. 18, No. 2, p 513-537, 1983. 157 Ref.

Descriptors: \*States rights, \*Legislation, \*Ground-water, Ownership of water, Legal aspects, Nebras-ka, Commerce clause, Water transfer.

The Sporhase decision, for the first time, saw the The Sporhase decision, for the first time, saw the Supreme Court declaring that groundwater is an article of commerce, and is therefore susceptible to congressional regulation. The Court further held that a Nebraska statute which prohibited the export of water to any state that did not provide reciprocal rights violated the commerce clause of the United States Constitution. This decision has prompted much anxiety in the western states causprompted much anxiety in the western states causprompted nuter analety in the western states caus-ing some legislatures to consider new or amended water laws which will constitutionally justify re-strictions on the use of water for interstate com-merce. (Baker-IVI) W84-03010

CONSTITUTIONAL LAW - WATER LAW - CONSTITUTIONALITY OF WATER EXPORT BANS AND LIMITATIONS ON INTERSTATE WATER ALLOCATION. SPORHASE V. NE-BRASKA EX REL. DOUGLAS, - U.S. -, 102 S.

J. Kelly. Land and Water Review, Vol. 18, No. 2, p 553-573, 1983, 107 Ref

Descriptors: \*Legislation, \*Water export, Water import, Legal aspects, Water supply development, Groundwater, Nebraska, Ownership of water, States rights, Federal jurisdiction, Water transfer.

### Nonstructural Alternatives—Group 6F

In reviewing the Sporhase decision it may appear at first to cripple the states in their efforts to preserve and conserve scarce water resources. The Court's definitive characterization of ground water as an article of commerce clearly limits the states' power to regulate in this critical area, and at the same time, opens the floodgates to ground water regulation by Congress. A closer look, however, reveals that state power to regulate ground water has not been severely curtailed. In fact, the Sporhase Court recognized that the states should be has not been severely curtailed. In fact, the Sporhase Court recognized that the states should be afforded considerable latitude when drafting ground water legislation. As long as the states either refrain from implementing overly discriminatory legislation or are granted congressional authorization to do so, the Court indicated that it would continue to place substantial weight on state conservation interests. It may happen in the future that arid Western states may become net water importers to insure plentiful water supplies. The Court's emphasis on state interests and non-discriminatory legislation, as evidenced in this deciriminatory legislation, as evidenced in this decicriminatory legislation, as evidenced in this deci-sion, is a victory for these states. (Baker-IVI) W84-03011

# NORTH DAKOTA CENTURY CODE SECTION 47-01-15: DETERMINING NORTH DAKOTA'S INTEREST IN THE BEDS OF NAVIGABLE

M. G. Fiergola. North Dakota Law Review, Vol. 59, No. 2, p 211-240, 1983. 208 Ref.

Descriptors: \*North Dakota, \*Navigable waters, \*Ownership of beds, Riparian land, Public trust, Constitutional law, State sovereignty.

The State of North Dakota entered the Union on an equal footing with the original states and acced-ed to sovereignty over the beds of navigable waters within the state. The beds of navigable waters are sovereign public trust lands of the State of North Dakota. Because these beds are subject to the public trust doctrine, the State has a duty to protect the public interest in these lands. Nevertheless, the North Dakota Supreme Court has inter-preted a state statute to grant that portion of the beds between the high and low water marks to riparians. Such an interpretation is contrary to a provision of the North Dakota Constitution, which provision of the Politi Datoia Consultation, which prohibits the State from giving away state property. Therefore, the State of North Dakota should plead and the courts should address this ownership issue so that the public interest in the State's sovereign lands may be protected. (Moore-IVI) W84-03012

# SPORHASE V. NEBRASKA EX REL. DOUG-LAS: DOES THE DORMANT COMMERCE CLAUSE REALLY LIMIT THE POWER OF A STATE TO FORBID (1) THE EXPORT OF WATER AND (2) THE CREATION OF A WATER RIGHT FOR USE IN ANOTHER

C. E. Corker. C. E. College University of Colorado Law Review, Vol. 54, No. 3, p 393-445, 1983. 179 Ref.

Descriptors: \*Water rights, \*State jurisdiction, \*Groundwater, \*Water export, \*Nebraska, \*Colorado, Overlying proprietor, Eminent domain, Commerce clause, Water management.

In the case of Sporhase v. Nebraska ex rel. Doug-las, the U. S. Supreme Court ruled that a state statute which forbids export of groundwater to another state because the latter would deny reci-procity is unconstitutional. It is felt that the Court failed to understand the basic necessities, rooted in laws of the physical universe, which demand active local government management of water re-sources. The Court failed to articulate dormant commerce clause which can accomodate the di-verse and local necessities of a federal union of continental size. Groundwater law, and its adminiscontinental size. Groundwater law, and its adminis-tration and management under government regula-tion is only one example of a problem that must be dealt with locally. Numerous cases are cited dem-onstrating water management decisions by state and federal agencies which affect inter-state water resources. Water is discussed here not as a com-

modity but rather as a management challenge re-quiring expert understanding of the geological im-plications and national concerns of managing this resource. (Wheatley-IVI) W84-03013

# TOWARD A UNIFIED REASONABLE USE AP-PROACH TO WATER DRAINAGE IN WASH-INGTON, G. C. Sisk. Washington Law Review, Vol. 59, No. 1, p 61-85, 1983. 233 Ref.

Descriptors: \*Reasonable use, \*Drainage, \*Washington, Legal aspects, Common enemy rule, Land use, Diversion.

Almost any development of land is likely to alter the flow of water draining from the land to the possible harm of neighboring property. Washing-ton has traditionally applied both the common enemy doctrine allowing diversion of diffuse sur-face water drainage with impunity and a strict liability standard prohibiting injurious obstruction or diversion of watercourses and natural drains. A reasonableness doctrine applied consistently and uniformly to all drainage water however charac-terized, would provide recovery to landowners suffering from an unreasonable invasion of exces-sive water depriving them of the free use and enjoyment of their property. A reasonable use doctrine would balance the reasonableness of the defendant's conduct and use of land against the defendant's conduct and use of land against the results of the harmful interference with the flow of both diffuse and channeled waters. It would be appropriate for the Washington legislature to adopt a unified standard of reasonableness for water drainage law. (Murphy-IVI) W84-03014

## THE POLITICS OF WETLAND CONSERVA-

THE FOLLING OF WEILAND CONSERVA-TION: A WILDLIFE VIEW, K. W. Harmon, and C. A. McConnell. Journal of Soil and Water Conservation, Vol. 28, No. 2, p 92-95, March-April, 1983. 2 Fig.

Descriptors: \*Political aspects, \*Policy making, \*Wetlands, Conservation, Soil conservation, Water conservation, Legislation.

Political action at many levels plays a major role in the competition between public and private views of wetlands. In general, attitudes toward wetlands have changed in the past two decades, most noticeably at the federal level, less so in the states and locally. Of the many legislative efforts considered in this area, Section 404 has caused a significant amount of debate. However, attempts to undermine two decades of gains in balancing wetland protection with economic activity are not restricted to 404 and the Corps of Engineers. The US department of Agriculture has retreated in its demands. The administration's resolve to resurrect a laissez-faire approach to management of finite demands. The administration's resolve to resurrect a laissez-faire approach to management of finite resources is illustrated in its proposal to repeal the Principles and Standards for Planning Water and Related Land Resources and issue them as guidelines. (Baker-IVI) W84-03054

### MANAGEMENT OF GROUNDWATER THROUGH MANDATORY CONSERVATION, M. J. Kelly.

nver Law Journal, Vol. 61, No. 1, p 1-24, 1983. 131 Ref.

Descriptors: \*Groundwater management, \*Legal aspects, Overdraft, United States, Public rights, Pumping, Restrictions.

Groundwater overdraft is a serious problem in many parts of the United States. The prevailing common law and statutory groundwater property systems do not provide a satisfactory means of controlling groundwater overdraft. The introduction of constraints on pumpers may force existing groundwater users to reduce their pumping, but it would not constitute a taking requiring comments. would not constitute a taking requiring compensa-tion. While there are precedents suggesting other-wise, application of such restrictions to existing

groundwater users is not viewed as an illegal. groundwater users is not viewed as an illegal, uncompensated taking of private property. Both the public rights theory and more traditional takings theories support this result. The public rights theory holds that when uses of property have mutually incompatible spillover effects, the government can restrict either use without affording compensation. Under the diminution in value theory, the government is not required to compensate unless its restrictions on property cause such a large decrease in property value that the owner suffers total or near total economic loss. (Murphy-IVI) IVI) W84-03234

## WATER RIGHTS FOR EXPANDED USES ON

FEDERAL RESERVATIONS, Air Force Academy, CO.

K. S. Samelson. Denver Law Journal, Vol. 61, No. 1, p 67-76, 1983. 73 Ref.

Descriptors: \*Water rights, \*National parks, Colorado, New Mexico, Forests, Parks, Prior appropriation, National Park System.

In November of 1982 the Colorado Supreme Court decided United States vs City and County of Denver, a leading case in the area of federal reserved water rights. The major issue addressed was the claim of the US for reserved water rights for national forests and national parks. Alternatives to national forests and national parks. Alternatives to the decision are explored from a legal and practical standpoint and a framework for resolving the conflict is presented. The dissent in US vs New Mexico asserted that the ruling denying additional reserved water rights for national forests with a 1960 priority date was dictum. The Colorado Suppose the confliction of the colorado Suppose the confliction of the colorado Suppose the colorado Suppo promy date was dictum. The Colorado Supreme Court was of the opinion that that ruling was binding even if dictum. In the future the courts may realize that the leeway to grant additional water for federal reservations with expanded purposes exists. (Baker-IVI) W84-03235

### BASELINE DELIMITATIONS AND MARI-

TIME BOUNDARIES, Rhode Island Univ., Kingston. Center for Ocean Management Studies. L. M. Alexander.

Virginia Journal of International Law, Vol. 23, 4, p 503-536, Summer, 1983. 8 Fig, 188 Ref.

Descriptors: \*Legal aspects, \*Boundaries, Boundary disputes, Water boundary, Law of the Sea, 1982 Convention, Coastal waters, State jurisdiction.

The official baseline along the coast is an important juridical feature of a state. The regulations for delimiting baselines are contained in articles 5 through 14 of the 1982 Convention. Although the articles have received general recognition as having the status of customary international law, certain ambiguities remain in the wording of some provisions. These ambiguities and apparent inconsistencies of action are explained and then baseline conditions are related to selected maritime bounds. conditions are related to selected maritime boundary situations. (Baker-IVI) W84-03237

### 6F. Nonstructural Alternatives

### PRIVATE ENFORCEMENT OF FEDERAL ANTIPOLLUTION LAWS THROUGH CITIZEN SUITS: A MODEL,

D. A. Feller. Denver Law Journal, Vol. 60, No. 4, p 553-571, 1983. 141 Ref.

Descriptors: \*Water pollution control, \*Public opinion, \*Law enforcement, Legislation, Legal as-

The history of citizen suits brought directly against polluters provides little indication of how a continuous, organized program of litigation would fare as a public interest enterprise. The stage is set for a systematic attempt to privately enforce environmental statutes. The evolution of federal administrations are considered administration.

### Field 6-WATER RESOURCES PLANNING

### Group 6F-Nonstructural Alternatives

trative machinery in support of those laws has created a store of discovery materials on which citizens may draw to identify and assemble cases. This is the cornerstone of any future private en-forcement venture. The EPA reporting machinery forcement venture. The EPA reporting machinery facilitates selection of violations and significantly reduces the costs of discovery. The judiciary seems favorably disposed to the award of attorneys fees to plaintiffs bringing effective or useful citizen suits. Though it is impossible to state with any certainty that courts will allow all plaintiffs the full value of the fees and costs incurred in litigation, it is clear that courts are currently more willing to make such awards than at any time in the next to is clear that courts are currently more willing to make such awards than at any time in the past. As a result, the financial deterrents are less threatening than in previous years. These favorable mechanical factors create the opportunity for an effectively organized and conducted private enforcement group to operate. (Baker-IVI)

W84-03002

WATER SUPPLY: A STATE OR LOCAL PROB-

LEM, SCS Engineers, Inc., Reston, VA.

L. L. Guy, Jr.
Current Municipal Problems, Vol. 10, No. 2, p 200-205, Fall, 1983.

Descriptors: \*Water supply, \*State jurisdiction, \*Local governments, Planning, Decision making, Management.

Problems in the municipal area of Washington, D.C. are briefly reviewed. Water supply development and protection is viewed in the main as a local responsibility and should not be given over to socal responsibility and anothed not be given over to the federal government. Federal control seems to result in long delays. The easiest problems to solve are the technical ones. The most difficult appear to be the political ones. An agreement is presented which has been devised in Northern Virginia, building on the awareness of the local elected officials that only they could deal with the problems of adequate water supply. This agreement has four parts: regional cost and benefit sharing for the Bloomington Reservoir, regional sharing of the cost and benefits for the proposed Little Seneca Reservoir, a regional operating agreement directed by the Interstate Commission's CO-OP Computer Program to coordinate withdrawals from each of the reservoirs and the Potomac, and modifications to the existing Potomac low flow allocation agreement. (Baker-IVI) W84-03232

LAND-USE POLICY BASED ON WATER SUPPLY.

Wilson (Lee) and Associates, Inc., Santa Fe, NM. L. Wilson. Water Resources Bulletin, Vol. 19, No. 6, p 937-942, December, 1983. 1 Fig, 2 Tab, 2 Ref.

Descriptors: \*Land use, \*Policy, \*Zoning, \*Groundwater storage, Groundwater mining, Groundwater recharge, Lot size, Water use, Water supply development, Groundwater management, Santa Fe county, New Mexico.

Santa Fe County, New Mexico, has adopted a land-use policy in which zoning densities provide a balance between the water use on a parcel of land and the water supply available beneath that land. In two of four mapped hydrologic zones, ground water in storage will be allowed to be mined to exhaustion in 100 years (40 years in urban areas). Elaewhere, the policy is for a steady state with use balanced by recharge. Equations to determine storage or recharge can be solved using site specific data or regional estimates of hydrologic conditions. Substantial reductions in the lot size requirements are allowed if water conservation convenients are allowed if water conservation convenients. tions. Substantial reductions in the lot size requirements are allowed if water conservation convenants are adopted. Public acceptance indicates that the policy successfully integrates technical and political concerns. It is simple to administer, yet reflects widely expressed public goals and values. (Author's abstract)
W84-03398

ASSESSING LAND-USE REGULATIONS IN COASTAL WETLANDS: THE CASE OF THE LONG POINT AREA, LAKE ERIE, ONTARIO,

British Columbia Univ., Vancouver. S. Jessen, J. C. Day, and J. G. Nelson. Coastal Zone Management Journal, Vol. 11, No. 1-2, p 91-115, 1983. 4 Fig. 6 Tab, 35 Ref.

Descriptors: \*Coastal zone management, \*Wet-lands, \*Land use, \*Regulations, \*Lake Erie, \*On-tario, Planning, Permits, Floods, Erosion, Lake

The Haldimand-Norfolk Region is subject to high The radiumand-Nortoik Region is subject to might potential coastal flooding and erosion hazards which pose severe management problems. The 1976 lakeshore regulation policy adopted by the Regional Municipality of Haldimand-Norfolk was aimed at directing development into areas less susceptible to flood and erosion hazards. This innovative the service was initiated at the amortical laurel see tive strategy was initiated at the municipal level as a component of the regional land-use planning process. Determination of efficiency and effective process. Determination of efficiency and effective-ness of the policy implementation process is based on analysis of permit approval files. All develop-ment applications submitted between 1976 and 1980 in the Turkey Point and Long Point Peninsu-las are evaluated. Those areas, the most susceptible to flood and erosion hazards. Of the total applica-tions submitted during the four-year study period. tions submitted during the four-year study period, 37% were in these areas. The policy was ineffective and inefficient in controlling development in the two peninsulas. Applications were approved in the majority of cases, despite regulatory prohibi-tion of developments in hazard-susceptible areas. A high percentage of applications involved some type of addition to existion infrastructures, such as type of addition to existion infrastructures, such as extensions to buildings and addessory buildings. Such applications, while not creating new primary development, increased the potential loss as a result of flooding and erosion if approved. The time necessary to arrive at final decisions was lengthy, and the process was inefficient. The inefficiency may partially explain the ineffectiveness of the policy in controlling development. The lengthy delays encountered may have led many to apply for permits only after they had violated the regulations by constructing the proposed developments. (Moore-IVI) W84-03425

### 6G. Ecologic Impact Of Water Development

THE 'DECADE OF THE ENVIRONMENT' IN THE U.S.S.R., San Diego State Univ., CA. Dept. of Geography.

San Diego San. P. R. Pryde. Science, Vol. 220, No. 4594, p 274-279, April, 1983. 1 Fig, 36 Ref.

Descriptors; \*Environmental protection, \*Water pollution control, USSR, Russia, Seas, Industrial wastes, Industrial discharges, Lakes, Lake Baikal, Irrigation, Consumptive use, Water levels, Caspian Sea, Volga River.

The state of resource conservation and environ-The state of resource conservation and environ-mental protection in the USSR is examined as it stood at the beginning of the 1980's as compared to the early 1970's. Much environmental improve-ment took place over the past 10 years. Two economic events in the 1970's were responsible for some of the changes. First, there was a general downturn in what had been for three decades an unbroken and vigorous rate of industrial expansion. Second, there were worldwide energy crises in 1973 and 1979. A call was made for a more effi-1973 and 1979. A call was made for a more ethi-cient use of natural resources. An increased em-phasis on recycling, including that of municipal wastes, has thus taken place during the past 10 years. During the 1970-1980 decade attention was directed toward the Caspian Sea problem, Lake Baikal, poaching, land reclamation, and the broad topics of air and water pollution. An underlying reason for the gloomy outlook of many environ-mentalists in the USSR can be found in the decidmentainsis in the OSSR can be found in the decidedly utilitarian approach to the natural environment espoused by many senior Soviet planning officials and even academicians. Even after two decades of concern over Lake Baikal, the future of this vast resource of clean water is far from secure. Some steps have been positive. In most major cities

primary treatment plants have been built and in some cases even secondary treatment facilities are available. Management of water quality and quantity in the Volga-Caspian basin has made progress. The reduction of the water surface level at the Caspian Sea due to the creation of upper basin Caspian Sea due to the Creation of upper dosin reservoirs and lower basin irrigation projects has received attention, and progress is being made. A relatively newer issue of similar scope concerns the Sea of Azov. (Baker-FRC) W84-02986

GEOTHERMAL EFFECTS ON STREAM BENTHOS: SEPARATE INFLUENCES OF THERMAL AND CHEMICAL COMPONENTS ON PERIPHYTON AND MACROINVERTE-

California Univ., Berkeley. Div. of Entomology For primary bibliographic entry see Field 5C. W84-03019

THE NORTHWEST'S HYDROELECTRIC HER-ITAGE: PROLOGUE TO THE PACIFIC NORTHWEST ELECTRIC POWER PLANNING AND CONSERVATION ACT,

Lewis and Clark Coll., Portland, OR. Northwest-ern School of Law. M. C. Blumm

M. C. Blumm. Washington Law Review, Vol. 58, No. 2, p 175-244, April, 1983. 386 Ref.

Descriptors: \*Reviews, \*Hydroelectric power, Powerplants, New Deal, Federal jurisdiction, Co-lumbia River Treaty, Hanford Agreement, Bonneville Project Act.

This review describes the development of hydro-electric power in the Northwestern section of the United States. Emphasis is given to the pre-New Deal era (specifically the twenties); the New Deal (including regulation of holding companies, the (including regulation of holding companies, the public-power crusade, the struggle over centralized planning, the Bonneville Project Act, and postage stamp rates and rural electrification); the War and its aftermath (including planning for the post war era, BPA as a regional chamber of commerce, and the defeat of the Columbia Valley Authority); the partnership years (nonfederal project development); the golden age (including doubling of industrial power sales, the Columbia River Treaty, and the Hanford Agreement); the rise and fall of the hydro-thermal power program; and a looking backward section including input in rise and fail of the hydro-thermal power program; and a looking backward section including input in the enlarged mandate, the Fish and Wildlife Program, allocation of power entitlements and the regional energy plan. (Baker-IVI) W84-03030

DUGOUTS IN EASTERN SOUTH DAKOTA: THEIR LOCATION IN RELATION TO BASIN WETLANDS AND STREAMS, South Dakota Cooperative Wildlife Research Unit,

K. B. McPhillips, L. D. Flake, W. A. Wentz, and

Journal of Soil and Water Conservation, Vol. 38, No. 5, p 434-436, September-October, 1983. 1 Fig. 2 Tab, 17 Ref. Federal Aid in Wildlife Restoration Program project W-75-R. South Dakota Agricultural Experiment Station project 7216-615. WRI project A-038-SDAK. Journal of Soil and Water Conservation, Vol. 38.

Descriptors: \*Ponds, \*Wetlands, \*Environmental effects, Drainage, Dugouts, South Dakota, Streams, Drainage basins.

An estimated 55,855 dugouts existed in eastern South Dakota in 1976. About 77% of these were located in wetland basins or streams. An analysis of dugout location in reference to wetland class and wetland numbers relative to class suggests a need for recommendations on dugout placement to minimize effects of the structures on wetlands. Dugout location in relation to numbers of ephemeral, temporary, seasonal and semipermanent wetlands were most likely present in seasonal and semipermanent basins, followed by temporary and ephemeral ponds. The disruption of local natural hydrologic

### Ecologic Impact Of Water Development—Group 6G

regimes in the area of the dugout may be so extensive that wetland vegetation can no longer survive outside of the dugout boundaries. Soil conservationists, wildlife managers, and others who make recommendations to landowners and others should be cognizant of the potential problems in dugout construction in wetlands. (Murphy-IVI) W84-03067

BIOLOGY OF THE ARCTIC GRAYLING, THY-MALLUS ARCTICUS (THYMALLIDAE), IN UST - ILIM RESERVOIR, Irkutskii Gosudarstvennyi Univ. (USSR). Ve S Kunchintskan B S Kunchintskan P

Ye. S. Kupchinskaya, B. S. Kupchinskiy, L. N. Ryzhova, P. Ya. Tugarina, and L. I. Tyutrina. Journal of Icthyology, Vol. 23, No. 1, p 47-56, 1983. 7 Tab, 12 Ref.

Descriptors: \*Fish behavior, \*Reservoirs, Environmental effects, Ilim, Graylings. ental effects, Water resource develops

Some ecological and physiological peculiarities (growth rate, feeding, condition factor, fecundity, blood composition, fatness) of the arctic grayling (Thymallus arcticus) of Ust'-lim Reservoir (East Siberia) may help determine the viability of Grayl-Siberia) may help determine the viability of Grayling in Ust'-Ilim reservoir. The grayling were restricted mainly to the upper section of the reservoir where conditions close to river conditions have been preserved, and to backwater zones in tributaries. The growth of the grayling in the reservoir is similar to the growth of fish in the river in this section prior to regulation of the discharge. The food composition has changed: under reservoir conditions the grayling feeds on Amphipoda and the larvae of Chironomidae. The blood and fatness indices of the grayling in Ust'-Ilim reservoir indicate high viability. Its abundance has decreased noticeably. This is connected with regulation of noticeably. This is connected with regulation of the discharge which has provoked a change in the complex of abiotic and biotic factors. An increase in grayling stocks in the reservoir is possible only by means of protective regulations and artificial culture and stocking of juveniles of an adequate size for survival. (Baker-IVI) W84-03103

TEMPERATURE PREFERENCE AND AVOID-ANCE BY ADULT RAZORBACK SUCKERS. Utah Cooperative Fishery Research Unit, Logan. For primary bibliographic entry see Field 5C W84-03315

HYDROELECTRIC DEVELOPMENT AND WILDERNESS CONFLICT IN SOUTH-WEST

TASMANIA,
Australian National Univ., Canberra. Centre for Resource and Environmental Studies. A. K. Dragun.

Environmental Conservation, Vol. 10, No. 3, p 197-204, 1983. 6 Fig. 5 Tab, 15 Ref.

Descriptors: \*Hydroelectric development, \*Wilderness, \*Tasmania, \*Australia, Environmental effects, Dams, Hydroelectric power, Cost analysis, Cost-benefits analysis, Alternative planning.

The hydroelectric developments planned for South-West Tasmania would inundate tracts having major wilderness and archaeological values as well as threaten a much larger area of wilderness. The development of the region is justified by the construction authority, in terms of an expected high rate of electricity demand towards the year 2000. A range of independent demand analyses suggest that the demand for electricity in Tasmania will not approach the Hydro-Electric Committee. suggest that the demand for electricity in I asmania will not approach the Hydro-Electric Commission's expectations. Thus a lag in demand may be identified which should provide time for a rigorous evaluation of the wilderness value of the region together with an appraisal of the alternative electricity-generation options. A cost advantage exists for the favored 'Gordon-below-Franklin' project. The opportunity-cost differential of this project relative to several less-damaging alternatives is slight, at least when the growth in wilderness and electricity demands are considered. The opportunity-cost tradeoff appears quite trivial when current

tourist and recreational impacts are accounted for. (Murphy-IVI) W84-03324

HYDROBIOLOGICAL STUDY OF A HARNESSED RIVER: THE VERDON (ETUDE HYDROBIOLOGIQUE D'UNE RIVIERE AMENAGEE: LE VERDON LES LACS DE BARRAGE ET LES TRONCONS DE COURS D'EAU A DEBIT DECLU E. DEBIT REGULE).

Direction de l'Equipement, Paris (France). Dept. of Sites, Environment and Information. A. Gregoire.

Houille Blanche, No. 2, p 105-114, 1983. 6 Fig, 2

Descriptors: \*Hydrobiology, \*Dams, \*Verdon River, Dam effects, Chemical properties, physical properties, Population dynamics, Hydraulics, Flow characteristics, Drainage, Trophic level, Ecologi-cal effects, Environmental effects.

The impact of five hydroelectric developments on the components of the ecosystem of a trout river (the Verdon) includes the conditions in reservoirs and the ecological problems specific to sections of streams with a regular flow. A study of the physical and chemical parameters of the water and the sediment in reservoirs ascertains the trophic potential of the environment. The follow up of the seasonal trend of the population of organisms corresponding to the main links of the food chain helps determine the trophic level of these reservoirs. The level of significance of the results for forecasting the change in the quality of water in other reservoirs, is assessed by appraising the relation of the five lakes of the Verdon to the French hydro-electric park. Measurement stations determine the respective impact of the dams on all the components of the ecosystem of the Verdon's flow by comparing mesological and biological struc-The impact of five hydroelectric developments on components of the ecosystem of the Verdon's flow by comparing mesological and biological struc-tures. The most substantial influence is the change in natural hydraulic conditions. There are measures that can limit the nuisance caused by fluctuations in water level, ten yearly drainage, damming and make-up water. (Murphy-IVI) W84-03360

HYDRO-ELECTRIC GENERATION AND THE ENVIRONMENT (LA PRODUCTION HYDROELECTRIQUE ET L'ENVIRONMENT),

Houille Blanche, No. 2, p 115-118, 1983. 6 Fig.

Descriptors: \*Hydroelectric plants, \*Environment, Environmental effects, Pollution load, Environ-mental impact statement, Plant populations, Opti-mum development plans.

Because of the diversity of hydro-electric installa-tions there is no standard solution to the environ-mental problem. By reason of the renewable and limited pollutance of the energy they produce the value of these installations has led project contractors to work out various approaches to their opti-mum environmental harmony. An overview of the impact of hydro-electric developments on the envi-ronment is developed by studying plants which may cause nuisances (for which remedies will be found) and plants whose effects are beneficial. There is a considerable tourist attraction to the water tracts created by hydro-electric develop-ments. (Murphy-IVI) W84-03361

MARINE LOG TRANSPORTATION AND HAN-DLING SYSTEMS IN BRITISH COLUMBIA: IMPACTS ON COASTAL MANAGEMENT,

Victoria Univ. (British Columbia). Dept. of Geog-

raphy.
M. C. R. Edgell, and W. M. Ross.
Coastal Zone Management Journal, Vol. 11, No. 12, p 41-69, 1983. 4 Fig, 1 Tab, 27 Ref.

Descriptors: \*Coastal zone management, \*British Columbia, \*Forestry, \*Log handling, Log transport, Estuaries, Resources management, Lumber industry, Mariculture, Recreation, Fisheries, Har-

Over 90% of British Columbia's annual log harvest enters into complex water-based systems of trans-portation, storage, and handling. These systems have considerable impacts on a wide range of coastal resources and uses. A number of site-specifcoastal resources and uses. A number of site-specific conflicts have arisen between forestry and preexisting or emerging values including fisheries,
mariculture, recreational boating, and harbor redeevelopment. Specific data on the impacts leading to
conflict are often fragmentary. However, concerns
about highly valued and fragile areas, particularly
estuaries, along with industrial concerns regarding
log losses and handling efficiency, have prompted
changes in log handling. These include moves to
dryland sorting, log bundling, and a redistribution
of forestry activities in estuaries to accommodate
other values. Conflict adjustments and responses es. Conflict adjustments and responses orner varues. Conflict adjustments and responses have in the past been largely ad hoc and attempted in a jurisdictional vacuum concerning control of coastal management. A more inclusive strategy is now slowly emerging, which involves the coordinated participation of federal, provinicial, and industrial interests. (Author's abstract) W84-03424

MULTILEVEL WITHDRAWAL AND WATER QUALITY,

Ecole Nationale des Ponts et Chaussees, Paris (France).

For primary bibliographic entry see Field 2H. W84-03472

ENVIRONMENTAL ASPECTS OF CLEARING

AND SNAGGING, Army Engineer Waterways Experiment Station, Vicksburg, MS. Environmental Lab. F. D. Shields, Jr., and N. R. Nunnally.

Journal of Environmental Engineering, Vol. 110, No. 1, p 152-165, February, 1984. 2 Fig, 1 Tab, 55

Descriptors: \*Clearing, \*Snagging, \*Environmental effects, Flood control, Vegetation, Hydraulic capacity, Detritus, Stream banks, Riparian vegeta-

Clearing and snagging is the removal of woody vegetation and debris from stream channels and banks to increase hydraulic capacity and prevent hazards to navigation or bridges. Clearing and snagging can reducing the frequency and duration of high frequency flooding in environmental sensitive locations. Hydraulic effects of clearing and snagging may be estimated by manipulating the resistance factor in the uniform flow equation. Riparian vegetation and the organic debris it produces influence stream morphology, water quality, and aquatic and terrestrial ecosystems. Complete clearing and snagging has detrimental effects on these stream characteristics; modified clearing and snagging is less damaging to the environment. Major modifications involve: selective removal and disposal of trees and snags based on size, and disposal of trees and snags based on size, location, condition, and habitat value; labor intensive construction techniques; access controls; and work scheduling to avoid fish spawning or other environmentally sensitive periods. Considerations for planning and design of a selective clearing and environmental project in the project in the project in the project in the project is project include selective of trees and ror pianning and design of a selective clearing and snagging project include selection of trees and snags for removal, disposal or utilization of debris, construction equipment and methods, access routes, revegetation, and protection of existing vegetation. Project success is ensured by an interdisciplinary approach, detailed specification, and tight supervision. (Moore-IVI) W84-03473

COMPARATIVE STUDY OF THE NUTRIENT-SALTS OF LAKE EDKU (EGYPT) BEFORE AND AFTER THE CONSTRUCTION OF ASS-WAN'S HIGH DAM IN 1958 AND 1969,

Baden-Wuerttemberg Landesanstalt fuer Umweltschutz (Germany, F.R.). M. W. Banoub.

Archiv fur Hydrobiologie, Vol. 99, No. 1, p 106-117, December, 1983. 6 Fig, 2 Tab, 7 Ref.

### Group 6G-Ecologic Impact Of Water Development

Descriptors: \*Dam construction, \*Lakes, \*Nutrients, Environmental effects, Lake Edku, Egypt, Aswan Dam, Phosphates, Silicates, Acidity.

aring the hydrochemical data of Lake Edku Comparing the indirection of the high dam, expressed several changes. The lagoon water-level variations decreased on amplitude and phase where the maximum shifted from summer to winter. Monthly chloride-average of the lagoon reached its maximum in winter in 1969 instead of summer in 1958 indicating the main invasion period by seawater. Phosphates increased from 0.036 to 0.081 mg P/ Fluspinates incleased rivinal of 300 to 300 flug 17 inter between 1958 and 1969. At the same time the Putilization in the lagoon decreased from 70 to 30%. Silicates decreased from 4.5 to 1.4 mg Si/liter on the average after cessation of the Nile floods. Indications suggesting change in the la-goons macrophytic and hydrophytic production are discussed in relation to the observed changes in are discussed in relation to the observed changes in water nutrients, pH, alkalinity and the water residence-time. A review of past productivity estimates is discussed in an effort to assess the primary productivity in the lagoon in relation to its past history and its fishery potential. (Baker-IVI)

### 7. RESOURCES DATA

### 7B. Data Acquisition

SPECTRAL MEASUREMENTS OF SURFACE SUSPENDED MATTER IN AN OXBOW LAKE IN THE LOWER MISSISSIPPI VALLEY,

ence and Education Administration, Beltsville, MD

J. C. Ritchie, F. R. Schiebe, and C. M. Cooper Journal of Freshwater Ecology, Vol. 2, No. 2, p 175-181, July, 1983. 6 Fig. 3 Ref.

Descriptors: \*Spectral analysis, \*Oxbow lakes, \*Suspended sediments, Lake Chicot, Arkansas, Surface water, Remote sensing.

Lake Chicot is an oxbow lake located adjacent to the west bank levee of the Mississippi River in Chicot County, Arkansas. Spectral reflectance was successfully used in a study of the lake designed to estimate the concentration of suspended solid in the surface water. Wavelengths between 700 and 900 nm gave the best estimate of the concentration of suspended solids. It should be possible to esti-mate the concentration of suspended solids in the surface water of Lake Chicot using remote sensing surface water of Lake Chicot using remote sensing technology. Thus Landsat images, aerial photogra-phy, or sensors mounted directly over the water surface and transmitting data could give a reser-voir manager valuable data about suspended solids concentration that would be useful in making deci-sions on the management of water inflow to a lake or reservoir to control water quality. (Baker-IVI)

#### MEASURING THE MARKET FOR WATER IN-STRUMENTS.

Pollution Engineering, Vol. 15, No. 8, p 30-33, August, 1983. 3 Fig. 5 Tab.

Descriptors: \*Measuring instruments, \*Monitoring, Water quality control, Wastewater disposal, Wastewater treatment facilities, Water treatment.

A survey was conducted to determine buying pat-A survey was conducted to determine buying patterns related to water quality instrumentation. To get the most out of a pollution control system, it needs process control instrumentation to ensure that it is running at design standards. Such parameters as temperature, flow, level, humidity, pH, and others should be continuously monitored when applicable. One important development in the field has been the recent establishment of an independent esting program. Of greatest concern at the moment in the industry is the control of hazardous and toxic waste materials. (Baker-IVI) WRALDHOUS

SOIL EROSION IN THE PALOUSE: AN 8. ENGINEERING WORKS AERIAL PERSPECTIVE,

Agricultural Research Service, Pullman, WA. For primary bibliographic entry see Field 2J. W84-03052

# THEORETICAL AND MEASURED EVAPORA-TION RATES FROM AN EXPOSED PICHE AT-

Purdue Univ., Lafayette, IN. Dept. of Agronomy. For primary bibliographic entry see Field 2D. W84-03213

### SEASONAL ESTIMATES OF TRANSPIRA-TION FROM A MILLET CROP USING A PO-ROMETER.

Nottingham Univ. (England). School of Agricul-For primary bibliographic entry see Field 2D. W84-03214

# STATISTICAL ASSESSMENT OF SOME ERRORS IN THERMOCOUPLE HYGROMETRIC WATER POTENTIAL MEASUREMENT,

Natal Univ., Pietermal Measurement, Natal Univ., Pietermalizburg (South Africa). Dept. of Soil Science and Agrometeorology. M. J. Savage, A. Class, and J. M. De Jager. Agricultural Meteorology, Vol. 30, No. 2, p 83-97, 1983. 3 Fig, 3 Tab, 21 Ref.

Descriptors: \*Measuring instruments, \*Water potentials, Hygrometry, Dewpoint, Calibration, Mathematical equations, Model studies.

Thermocouple hygrometers are considered by some workers as the standard for water potential measurements under temperature controlled condi-tions, but this confidence does not extend to field conditions. A model for calculating some errors in the measurement of water potential for individual thermocouple hygrometers used in the dewpoint or psychrometric mode is based on calculation of the relative standard error in measured thermocouple psychrometric water potential as a function of temperature. The errors were shown to arise from temperature. The errors were snown to artise from the variability in the determination of the slope (S) and intercept (I) of the psychrometer block temperature (T) verses 1/kT curve, the error in voltage measurement (which includes zero offset and electronic noise errors) and error in temperature measurement. Assuming a zero offset of 0.5 microV and an error in temperature 0.25 degrees C and a measured water potential of -1250 kPa, the total error ranged between 15.6 and 5.5% (at 0 and 45 degrees C, respectively) for the worst psychrometer, and between 5.9 and 2.2% for the best. A similar statistical analysis showed that the magnitude of the error in dewport water potential was critically dependent on the dewpoint cooling coefficient. It is recommended that all parameters required for the application of the model be known a priori, so that the error value may be determined routinely. (Baker-IVI). W84-03215

# SUPERCOOLED LIQUID WATER AND ICE CRYSTAL DISTRIBUTIONS WITHIN SIERRA NEVADA WINTER STORMS,

Bureau of Reclamation, Auburn, CA. Auburn-Folsom South Unit. For primary bibliographic entry see Field 2B. W84-03303

# AUTOMATED RAIN SAMPLER FOR TRACE ORGANIC SUBSTANCES,

National Water Research Inst., Burlington (Ontar-io). Environmental Contaminants Div. For primary bibliographic entry see Field 5A. W84-03330

# INFRARED REMOTE SENSING FOR MONITORING RAINFALL,

EROS Data Center, Sioux Falls, SD. For primary bibliographic entry see Field 2B.

### 8A. Structures

# EVALUATING THE SAFETY AND SEISMIC STABILITY OF EMBANKMENT RESER-

Converse Consultants, Inc., Seattle, WA

D. E. Ryden.

Journal of the American Water Works Association, Vol. 76, No. 1, p 35-39, January, 1984. 3 Fig. 1 Tab, 1 Ref.

Descriptors: \*Reservoirs, \*Safety, Earthquakes, Seattle, Washington, Earth dams, Embankments, Seismic properties, Stability analysis.

Open storage reservoirs formed by earthen em-bankments may be classified as facilities with a high seismic hazard potential, especially if the surrounding areas have been heavily developed. A geotechnical evaluation of 12 open embankment reservoirs was undertaken in Seattle, Washington, reservoirs was undertaken in Seattle, Washington, to determine the safety and seismic stability of the facilities in the event of earthquakes. Most of the reservoirs were constructed from 1901 through 1931 with the oldest being Volunteer Reservoir and the newest being Lake Forest Reservoir (1962). They were typically formed by using a natural topographic swale or slope, escavating into the upper soil levels, and reusing the excavated material to construct an earth embankment 4.5 to material to construct an earth embankment 4.3 to 9.1 m high at the lower end of the natural grade. It was recommended that grass be kept trimmed and the brush thinned to permit observation of poten-tial problems such as seepage or slumping. Rodent burrows were noted and it was felt they should be eliminated as their burrow systems could weaken the embankments. Outlet controls should be provided inside the reservoir as well as at the outboard toe of the embankment. Underdrain outlets sourd use or the embankment. Underdrain outlets should be metered to provide a more accurate indication of the quantity of loss through the underdrain systems. A regular periodic inspection program is to be continued. (Baker-IVI) W84-03139

### KEEPING OLD RESERVOIRS ACTIVE,

Portland Bureau of Water Works, OR. F. Whitfield.

Journal American Water Works Association, Vol. 76, No. 1, p 40-43, January, 1984. 3 Fig.

Descriptors: \*Reservoirs, \*Maintenance, Portland, Oregon, Open reservoirs, Water storage, Vandalism, Cleaning.

Experience in Portland, Oregon with old open storage reservoirs as well as a variety of covered storage facilities has evolved into a routine cleaning, maintenance, and protective program. Storage of chlorinated water in the open reservoirs in Portland's system requires periodic cleaning to prevent water quality deterioration, and protection of these reservoirs from the public is also important. The Portland Water Board has significantly extended the useful life of the aging facilities with extended the useful life of the aging facilities with these procedures. These open reservoirs are located in parklike settings. Most are accessible to the public and are about 80 years old. It is the practice in Portland to clean open reservoirs every six months in the spring and fall. Use of hidden cameras guards against vandalism. (Baker-IVI) W84-03140

# RBC BROAD-CRESTED WEIRS FOR CIRCU-LAR SEWERS AND PIPES,

National Aeronautics and Space Administration, Greenbelt, MD. Goddard Space Flight Center. A. J. Clemmens, M. G. Bos, and J. A. Replogle. Journal of Hydrology, Vol. 68, p 349-368, 1984. 8 Fig, 2 Tab, 23 Ref.

Descriptors: \*Weirs, Pipes, Sewer systems, Flow,

Existing experience with and theory of long-throated flumes has led to the adaptation of the

### Rock Mechanics and Geology—Group 8E

RBC Broad-crested weir to flow in circular pipes flowing partly full. The ideal flow equations were solved and the resulting stage-discharge relation-ship is listed. A mathematical model of flow over solved and the resulting stage-discharge relationship is listed. A mathematical model of flow over broad-crested weirs was used to determine the stage-discharge relationship for actual flow. The results were fit to an empirical equation in non-dimensional form for a wide range of sill heights and pipe sizes. Maximum capacity and head loss requirements for any given weir size are given. Maximum calibration errors result from several sources including: basic calibration, effects of friction not accounted for by Froude modeling, effects of empirical curve fit, and errors in zero setting and depth detection. An example is given which shows how to design these weirs to minimize the effects of the weir on flow conditions in the channel. In many situations, these weirs can be designed to pass a majority of the sediment which moves through the channel. These weris are simple and inexpensive to construct and should be easily adapted to current measurement needs in circular adapted to current measurement needs in circular open channels. (Baker-IVI) W84-03350

### 8B. Hydraulics

OPERATIONAL FLOOD ROUTING FOR HYDROELECTRIC PLANTS,

National Technical Univ., Athens (Greece). Dept. of Civil Engineering. For primary bibliographic entry see Field 4A. W84-0293

THE EFFECTS OF CURVATURE IN SUPER-CRITICAL SIDE WEIR FLOW, Sheffield City Polytechnic (England). Dept. of

Sherifield City Folytesinis Carlos Civil Engineering.
D. J. Balmforth, and E. J. Sarginson.
Journal of Hydraulic Research, Vol. 21, No. 5, p. 333-343, 1983. 6 Fig. 1 Tab, 9 Ref.

Descriptors: \*Curvature, \*Supercritical flow, \*Weirs, Mathematical models, Side weirs, Water depth, Flow discharge, Channel slope, Critical

A method for analyzing supercritical flow in a channel fitted with a side weir has been developed and tested against experimental data. Results of the experimental program have established the conditions under which supercritical flow occurs along with the state of the time experiments. a side weir, and showed that in cases where the flow upstream of the weir is subcritical the draw-down to supercritical flow produces sufficient cur-vature of the streamlines to affect the vertical pressure distribution. Modification of the differenpressure distribution. Modification of the differential equation to allow for curvature effects has significantly improved the accuracy of computation of depths and discharges. The depth at the upstream end of the weir is shown to be a function of the upstream critical depth, the weir crest height and the slope of the channel, and the rate of change of surface curvature along the upstream portion of the weir is found to depend on the upstream critical depth. Apart from these relationships little use is made of empirical formulae in analysis, so that the method may be applied to any side weir where supercritical low occurs. side weir where supercritical low occurs. W84-03165

DIFFUSION MODEL FOR DEGRADING

Ahmadu Bello Univ., Zaria (Nigeria). Dept. of Water Resources and Environmental Engineering. M. A. Gill. Journal of Hydraulic Research, Vol. 21, No. 5, p

369-378, 1983. 5 Fig, 8 Ref.

Descriptors: \*Channel degradation, \*Diffusion, \*Mathematical models, Fourier series, Error function, Hydraulic models, Dam effects, Sedin

Degradation problems below dams and in a chan-nel whose downstream end is suddenly lowered are formulated for rectangular channels of finite length. Two specific cases are considered: degra-dation of channel beds due to sudden reduction of

sediment supply at an upstream location with flow conditions otherwise remaining unaltered in its original steady conditions; and degradation of channel beds induced by abrupt lowering of bed level at the downstream end. The first of these level at the downstream end. The first of these situations frequently occurs downstream of dams. The proposed analytical solutions cover the complete range of transient phase terminating in the final steady flow regime. Two types of solutions are obtained. The Fourier series solutions is best suited for computations at large values of time and the error function solution at small values of time. (Moore-IVI)

FLOOD ROUTING THROUGH A FLAT, COM-PLEX FLOODPLAIN USING A ONE-DIMEN-SIONAL UNSTEADY FLOW COMPUTER PRO-GRAM.

Hydrologic Engineering Center, Davis, CA. J. C. Peters.

Water Resources Bulletin, Vol. 19, No. 6, p 913-920, December, 1983. 9 Fig, 4 Ref.

Descriptors: \*Flood routing, \*Floodplains, \*Unsteady flow, \*Computer models, Flood data, Hydrographs, Flood hydrographs, Model studies, Simulation, Flood waves, Passaic River, New

The routing of flood waves through the Central Basin of the Passaic River in New Jersey is com-plex because of flat gradients and flow reversals. The one-dimensional unsteady flow program DWOPER simulates flood wave movement through the Basin. A historical event was used for calibration, and two synthetic events were simulatcalibration, and two synthetic events were simulat-ed. Boundary conditions consisted of discharge hydrographs at inflow points to the study area, local flow hydrographs at interior points, and a stage discharge relation for flow over the crest of a diversion dam at the basin outlet. Manning's values were adjusted based on stage and discharge data for the historical event. Verification data were not available for events comparable in magnitude to the synthetic events. Included are techniques for characterizing the flow system, model calibration, techniques for representing a tunnel diversion, and simulation results. (Murphy-IVI) W84-03395

### EXTREMAL HYPOTHESES FOR RIVER REGIME; AN ILLUSION OF PROGRESS, G. A. Griffiths.

Water Resources Research, Vol. 20, No. 1, p 113-118, January, 1984. 1 Fig, 34 Ref.

Descriptors: \*Channel stability, \*Alluvial channels, \*Mathematical equations, Sediment transport, River regimes, Flow resistance, Sediment dis-

The extremal hypotheses of minimum stream power, minimum unit stream power, minimum power, minimum unit stream power, minimum energy dissipation rate, and maximum sediment transport rate, when combined with conventional sediment transport and flow resistance equations, lead to conclusions incompatible with observations. For wide, straight, unconstrained alluvial reaches in equilibrium, these conclusions include reaches in equilibrium, these conclusions include that the Einstein sediment discharge and Shields entrainment function are nearly constant, the magnitude of the particular constants depending only on the hypothesis and equations used, whereas data from flumes and natural rivers show that both expressions are highly variable in stable channels. Constancy of the Einstein and Shields expressions provides, in fact, a sufficient but unnecessary constitution for aboves of the stability. In the measurement friedling for a house at each better the constant of the stable constant of the stable and the stable constant of the stable dition for channel stability. In the maximum friction factor hypothesis there is no maximum for friction factor when channel width, depth, and slope are dependent variables. Variational principles may one day supply a solution to the problem of alluvial channel stability, but current formulations of the mentioned hypotheses require redefinition. (Author's abstract) W84-03417

### 8D. Soil Mechanics

RECENT DEVELOPMENTS ON THE PROBA-BLE MAXIMUM PRECIPITATION (PMP) ES-TIMATION IN CHINA, East China Technical Univ. of Water Resources, Nanjing. Dept. of Hydrology. For primary bibliographic entry see Field 2B. W84-03347

SENSITIVITY OF OUTFLOW PEAKS AND FLOOD STAGES TO THE SELECTION OF DAM BREACH PARAMETERS AND SIMULA-TION MODELS, Illinois State Water Survey Div., Champaign.

K. P. Singh, and A. Snorrason.

Journal of Hydrology, Vol. 68, p 295-310, 1984. 5 Fig, 5 Tab, 9 Ref.

Descriptors: \*Dam failure, \*Design criteria, \*Flood control, Floods, Dams, Earth dams, Model studies, Channels, Dam construction,

A detailed study of historical earthdam failures due to overtopping was reviewed to identify important breach parameters. Various combinations of breach parameters (failure time, depth of overtopbreach parameters (failure time, depth of overtopping, and breach size) were used for breach simulations in both the US Army Corps of Engineers
Hydrologic Engineering Center model and the National Weather Service model. In general, the
flood stage profiles predicted by the NWS were
smoother and more reasonable than those pedicted
by the HEC. For channels with relatively steep
these the cented of concern for the unit of the service of the control slopes, the methods compared fairly well, whereas for the channels with mild slope, the HEC model often predicted oscillating, erratic flood stages, mainly due to inability to route flood waves satisfactorily in non-prismatic channels. The breach outflow peaks are affected significantly by the breach size but less so by the depth of overtopping. The ratio of outflow peak to inflow peak and the effect of failure time on outflow decrease as the effect of failure time on outflow decrease as the drainage area above the dam and impounded storage increase. Flood stage profiles predicted with cross-sections taken from 7.5 foot maps compared favorably with those predicted using surveyed cross-sections. For the range of breach parameters studied, the range of outflow peaks and flood stages downstream from the dam can be determined for regulatory and disaster prevention measures. (Baker-IVI) W84-03348

### 8E. Rock Mechanics and Geology

EROSIONAL UNLOADING AND FLUID PRES-SURES ROCKS, HYDRAULICALLY

Geological Survey, Reston, VA. C. E. Neuzil, and D. W. Pollock. Journal of Geology, Vol. 91, No. 2, p 179-193, 1983. 7 Fig, 35 Ref.

Descriptors: \*Erosion, \*Fluid pressures, \*Rock properties, Rock mechanics, Hydraulic permeability, Hydraulic friction, Pore pressure, Mathematical analysis, Hydrodynamics.

When rocks deform in response to changes in stress, the small variations in pore volume that occur affect the pore fluid pressure. The changes in fluid pressure can be significant if the rate of change of stress is large relative to the rate at which pressure perturbations are dissipated by flow. It has been proposed previously that the gradually increasing loads on sediments undergong burial can cause excess fluid pressures. We hypothesize that the opposite effect, depression of pore pressure resulting from rebound during erosional unloading, also may occur in certain geologic settings. Simple theoretical treatment of the problem indicates that rocks with small hydraulic diffusivity, such as some shales, could experience significant pore pressure decreases when unloaded significant pore pressure decreases when unloaded by moderate rates of erosion. The analysis further indicates that decreases sufficient to produce nega-

### Field 8—ENGINEERING WORKS

### Group 8E-Rock Mechanics and Geology

tive pressures can occur. No theoretical bar to this condition exists, and it has been achieved in the condition exists, and it has been achieved in the laboratory. However, in subsurface environments, it is perhaps more likely that degassing of the pore fluid and resulting increase of gas volume, or desaturation, would occur. Thus it appears that a mechanism exists for generating significant underpressuring and unsaturated conditions below the water table in thick sequences of poorly permeable rock. The analysis also shows that in formations with depressed fluid pressures the groundwater flow is inward from the permeable boundaries for long periods of time. These results may be of importance if toxic materials are to be isolated in 'fight' rocks. (Author's abstract)

W84-03236

A STOCHASTIC MODEL OF A FRACTURED ROCK CONDITIONED BY MEASURED INFORMATION,

FORMATION, Royal Inst. of Tech., Stockholm (Sweden). Dept. of Water Resources Engineering. J. Andersson, A. M. Shapiro, and J. Bear. Water Resources Research, Vol. 20, No. 1, p 79-88, January, 1984. 8 Fig, 3 Tab, 20 Ref, 1 Append.

Descriptors: \*Geologic fractures, \*Stochastic process, \*Model studies, \*Rock properties, Cores, Groundwater movement, Statistical models.

A method for the modeling of a fractured rock is developed which takes into account the uncertainty in the fracture network geometry as well as actually measured information, such as that obtained from cores. Based on certain simplifying assumptions, of which the most important are planar and independent fractures, a stochastic a priori model is formulated. The real fracture netpriori model is formulated. The real fracture network is assumed to be a realization of this a priori model. Since measurements are performed on the real network, two different kinds of information are made available. The first kind is of deterministic nature and expresses the actual location of intercepted fracturers, by inference the other part is probabilistic, given as the probability of observing a fracture intersecting the model region. This observation probability is shown to depend on the a priori model, on the geometry of the region and on the measurements only. A conditional model is formulated where each realization consists of the

actually observed fractures and an additional number of stochastically generated fractures obtained by employing the probabilistic information. The number of stochastically generated fractures is a stochastic variable, the distribution of which depends on the number of fractures observed and the observation probability. Even if the rock is penetrated with only a few cores, it is possible to quantify the statistics of properties, such as the total leakage into a tunnel or the concentration of pollutants close to a waste repository. By increasing the number of cores, the uncertainty in these values is reduced. The amount of uncertainty reduction can be quantified by applying the model of the investigated domain taking into account the information from the additional measurements. As a demonstration, the proposed model is applied to a simple problem of steady state two-dimensional flow in a vertical plane. It appears that the technique presented may serve as a powerful tool for quantifying uncertainties in flow problems and in providing guidance on how to acquire additional morphylation of the fractured network in a given providing guidance on how to acquire additional information of the fractured network in a given domain of fractured rock. (Author's abstract)

### 81. Fisheries Engineering

INFLUENCE OF DEGREE OF STREAM TURBULENCE ON THE MACNITUDE OF THE CRITICAL CURRENT VELOCITY FOR FISH, Akademiya Nauk SSSR, Moscow. Inst. of Evolutionary Morphology and Animal Ecology.

D. S. Pavlov, M. A. Skorobogatov, and L. G.

Sntai.
Doklady Biological Sciences, Vol. 267, No. 1-6, p 560-562, November-December, 1982. 2 Fig. 5 Ref. Translated from Doklady Akademii Nauk SSSR, Vol. 267, No. 4, p 1019-1021, December, 1982.

Descriptors: \*Fish behavior, \*Tur Streams, Fish, Fisheries, Fish management. \*Turbulence,

One of the most important characteristics of a stream is the degree of its turbulence. In fish motion the critical current velocity equals the minimum current velocity that exhausts a fish. In order to increase the range of change in the turbulence intensity in the stream, a system of races was

created above the upper net with the help of a submerged hydraulic spring, acting as a generator of elevated turbulence. Young roach were used in the study. A stream with a higher degree of turbulence possesses a greater kinetic energy for fish. Therefore, the energy expenditures of fish will be higher in such currents, leading to a decline in the critical velocity. The findings should be taken into account in the control of fish behavior. An increase in the degree of turbulence in active fishing equipment, such as a trawler, will promote the most rapid exhaustion of the fish and an increase in the catch. At the same time an increased stream the catch. At the same time an increased stream turbulence in the fish tanks of fish-passing structures is undesirable as it will result in the loss of fish to the current. (Baker-IVI)

W84-03027

HYDRAULIC CHARACTERISTICS OF THE CURRENT THAT PRODUCES ROUTES FOR FISH MOVEMENT, Akademiya Nauk SSSR, Moscow. Nauchnyi Sovet po Neorganischeskoi Khimii. D. S. Pavlov, A. Sh. Barekyan, M. A. Skorobogadov, and L. G. Shtaf. Doklady Biological Sciences, Vo. 270, No. 1-6, p 230-233, May-June, 1983. 2 Fig, 5 Ref. Translated from Doklady Akademii Nauk SSSR, Vol. 270, No. 6, p 1513-1516, June, 1983.

Descriptors: \*Fish behavior, \*Water currents, \*Dams, Powerplants, Hydraulic structures, Spawning, Fish, Uglichskow Reservoir.

A model hydrosystem with a fish passing structure arranged along the axis of the spillway front was set up in a hydraulic tank of 6.5 m length and 1.2 m width. Various hydraulic regimes were created in the lower water race of the model with the help of the gates of the model itself. The current depth in the lower water race of the hydrosystem com-prised 0.08 m. Current hydraulic characteristics seen to be involved in the production of routes of fish movement in a current included the longitudiis novement in a current included the longitudinal velocity component, the turbulence intensity, and the transverse gradient. The data obtained was used to develop a method for predicting the entrance of fish into fish-passing structures. (Baker-IVI) W84-03029

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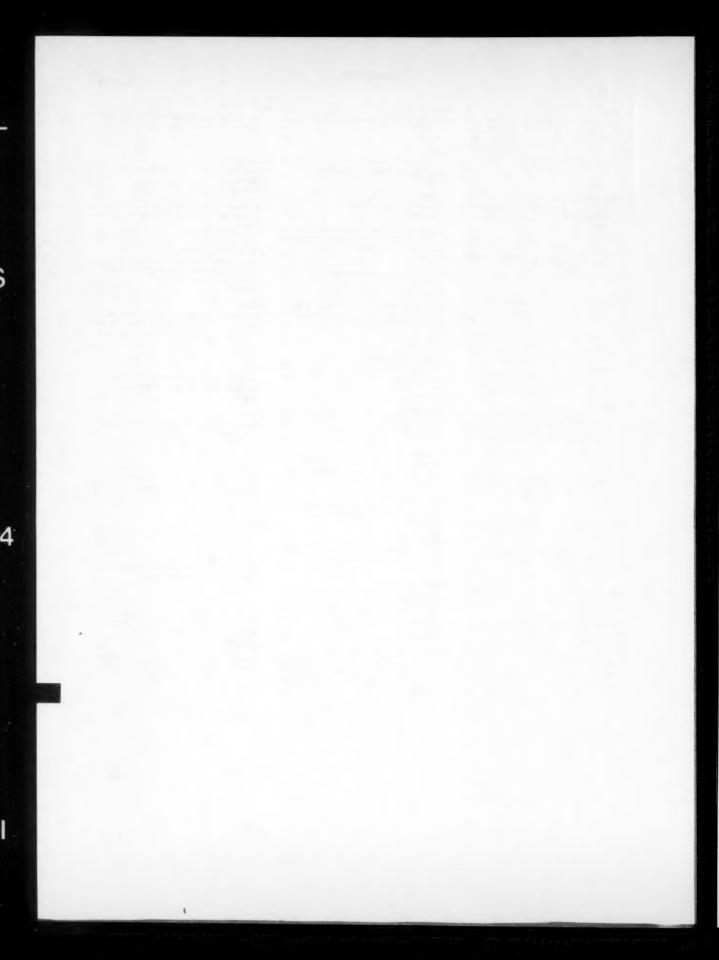
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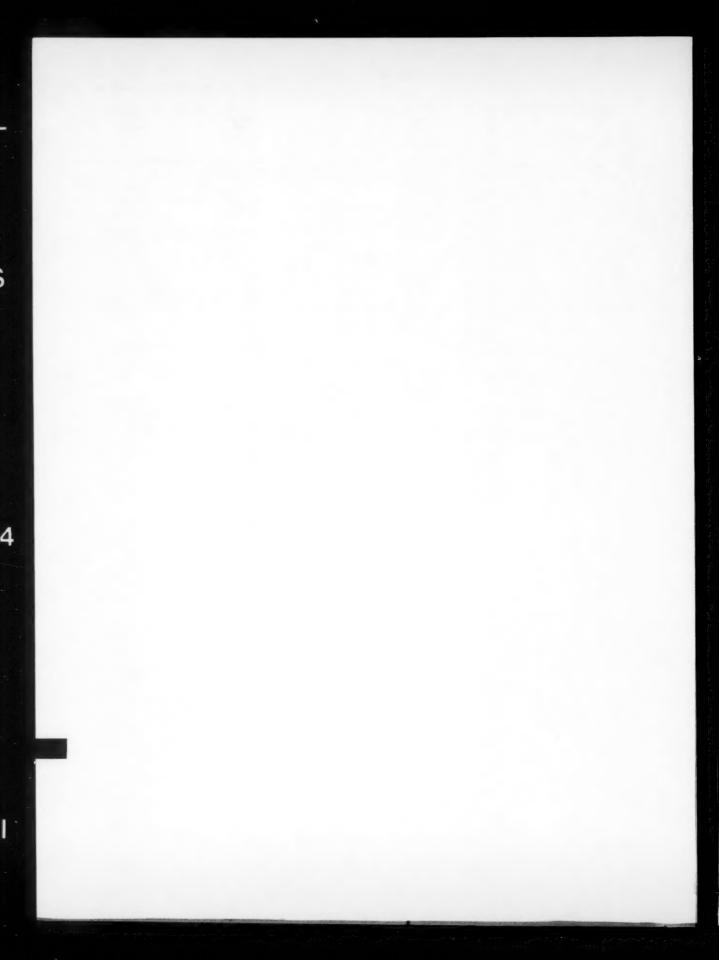
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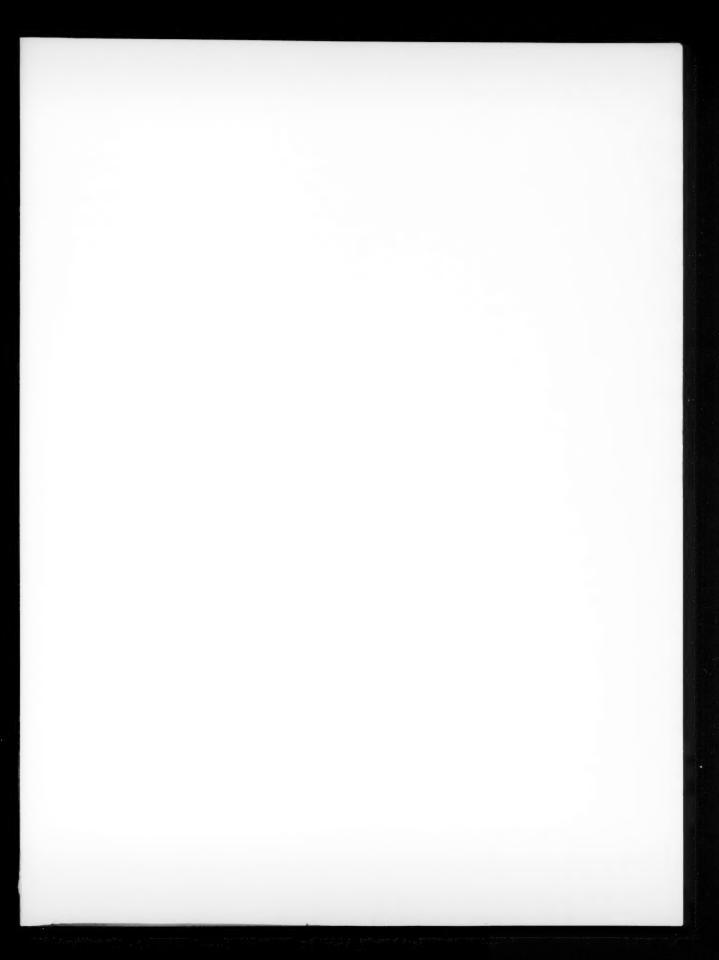
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